

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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ENGINEERING: A CONTINUING
BIBLIOGRAPHY WITH INDEXES
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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 757 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

<i>Scientific and Technical Aerospace Reports (STAR)</i> (N-10000 Series)	N93-19413 — N93-22080
<i>International Aerospace Abstracts (IAA)</i> (A-10000 Series)	A93-23761 — A93-29780

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1993 will be published in early 1994.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

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TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED
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ACCESSION NUMBER → **N93-10098*** # Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics. ← **CORPORATE SOURCE**

TITLE → **NAVIER-STOKES DYNAMICS AND AEROELASTIC COMPUTATIONS FOR VORTICAL FLOWS, BUFFET AND AEROELASTIC APPLICATIONS Progress Report, 1 Oct. 1991 - 30 Sep. 1992**

AUTHOR → **OSAMA A. KANDIL** Sep. 1992 38 p

CONTRACT NUMBER → (Contract NAG1-648)

REPORT NUMBERS → (NASA-CR-190692; NAS 1.26:190692) Avail: CASI HC A03/MF ← **PUBLICATION DATE**
A01 ← **PRICE CODE**
← **AVAILABILITY SOURCE**

The accomplishments achieved during the period include conference and proceedings publications, journal papers, and abstracts which are either published, accepted for publication or under review. Conference presentations and NASA highlight publications are also included. Two of the conference proceedings publications are attached along with a Ph.D. dissertation abstract and table of contents. In the first publication, computational simulation of three-dimensional flows around a delta wing undergoing rock and roll-divergence motions is presented. In the second publication, the unsteady Euler equations and the Euler equations of rigid body motion, both written in the moving frame of reference, are sequentially solved to simulate the limit-cycle rock motion of slender delta wings. In the dissertation abstract, unsteady flows around rigid or flexible delta wings with and without oscillating leading-edge flaps are considered.

L.R.R.

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ACCESSION NUMBER → **A93-12007*** National Aeronautics and Space Administration. ← **CORPORATE SOURCE**
Langley Research Center, Hampton, VA.

TITLE → **NUMERICAL SIMULATIONS OF HIGH-SPEED FLOWS ABOUT WAVERIDERS WITH SHARP LEADING EDGES**

AUTHORS → **KEVIN D. JONES and F. C. DOUGHERTY** (Colorado Univ., Boulder) ← **AUTHORS' AFFILIATION**

JOURNAL TITLE → **Journal of Spacecraft and Rockets** (ISSN 0022-4650) vol. 29, no. 5 Sept.-Oct. 1992 p. 661-667. Research supported by Univ. of Colorado and DLR refs

CONTRACT NUMBER → (Contract NAG1-880)
Copyright

A procedure is developed for the numerical simulation of stagnation-free inviscid supersonic and hypersonic flows about waveriders with sharp leading edges. The numerical approach involves the development of a specialized grid generator (named HYGRID), an algebraic solution-adaptive grid scheme, and a modified flow solving method. A comparison of the results obtained for several waverider geometries with exact solutions, other numerical solutions, and experimental results demonstrated the ability of the new procedure to produce stagnation-free Euler solutions about sharp-edged configurations and to describe the physics of the flow in these regions.

I.S.

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 291)

May 1993

01

AERONAUTICS (GENERAL)

A93-24107

REPAIR OF DELAMINATIONS AND IMPACT DAMAGE IN COMPOSITE AIRCRAFT STRUCTURES

A. J. RUSSELL, C. P. BOWERS, and A. J. MOSS (Defence Research Establishment Pacific, Victoria, Canada) *In* Composite structures 6; Proceedings of the 6th International Conference, Paisley College of Technology, United Kingdom, Sept. 9-11, 1991 London and New York Elsevier Applied Science 1991 p. 145-159. refs
Copyright

This paper examines the degree to which the structural integrity of delaminated and impact damaged graphite/epoxy aircraft components can be restored by completely infiltrating the matrix cracks and delaminations with a specially formulated epoxy resin. Tests are described for evaluating the ability of the repaired laminates to sustain (1) in-plane compression loads, (2) interlaminar shear loads, and (3) low velocity impact. The experimental results support the conclusion that resin injection can be a very effective means of repairing delaminations. Author

A93-24299#

V-22 PROGRAM OVERVIEW

VICTOR THOMBS (U.S. Navy, Naval Air Systems Command, Washington) Aug. 1992 5 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 (AIAA PAPER 92-4277)

A program management and appropriations status evaluation is presented for the V-22 tilt-wing VTOL aircraft. As of the present writing, fiscal year 1992 funds had not been released for pursuit of V-22 engineering and manufacturing development. The program office has been responding to requirements for various program plans from the staffs of the Navy Acquisitions Executive and the Office of the Secretary of Defense; these plans reflect different assumptions as to aircraft configuration and spending ceilings. The key issue in configurational considerations has been the amount of weight to be removed from the aircraft. O.C.

A93-25325 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE REBIRTH OF SUPERSONIC TRANSPORT

ROBERT ROSEN (NASA, Ames Research Center, Moffett Field, CA) and LOUIS J. WILLIAMS (NASA, Washington) Technology Review (ISSN 0040-1692) vol. 96, no. 2 Feb.-Mar. 1993 p. 22-29.

Copyright

A development status evaluation is presented for the aerodynamic and propulsion system technologies that will be required to make a second-generation SST, or High Speed Civil Transport (HSCT) sufficiently (20 dB) quieter near airports and in supersonic cruise (sonic boom), less NO(x)-emitting, and longer-range than Concorde. NASA's Ames, Lewis, and Langley facilities are intensively concerned with the development of such

an environmentally benign and economically feasible Mach 2.4 HSCT; efforts have concentrated on the design of a powerplant with the requisite specific fuel consumption, low emissions, and low noise. O.C.

A93-25516*# National Aeronautics and Space Administration, Washington, DC.

NASA'S HYPERSONIC FLIGHT RESEARCH PROGRAM

ISAIAH BLANKSON and JON PYLE (NASA, Hypersonics Research Div., Washington) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0308) Copyright

The NASA hypersonic flight research program is reviewed focusing on program history, philosophy, and rationale. Flight research in the high Mach numbers, high dynamic pressure flight regime is considered to be essential to the development of future operational hypersonic systems. The piggy-back experiments which are to be carried out on the Pegasus will develop instrumentation packages for hypersonic data acquisition and will provide unique data of high value to designers and researchers. O.G.

A93-26878

RECENT DEVELOPMENTS IN INTERNATIONAL LAMINAR FLOW RESEARCH PROGRAMS FOR TRANSPORT AIRCRAFT [ETAT D'AVANCEMENT DES PROGRAMMES INTERNATIONAUX SUR LA LAMINARITE DES AVIONS DE TRANSPORT]

J. PREIST and J. RENEUX (ONERA, Chatillon, France) ONERA, TP no. 1992-163 1992 20 p. In French. refs (ONERA, TP NO. 1992-163)

Three research programs conducted by European partnerships to study the potential advantages of natural and hybrid laminar flow are described. The first program is devoted to the flight testing of an NLF (natural laminar flow) glove in order to validate the transition criteria used in stability calculations. The second program involves the wind tunnel testing of an HLFC (hybrid laminar flow control) glove to study the feasibility of hybrid laminar flow and the effect of suction on boundary layer stability. The third program is devoted to the testing of an HLFC Airbus A320 tail fin in the S1MA wind tunnel. For each of these programs, the aerodynamic problems encountered in maintaining laminar flow are presented together with the main solutions adopted. L.M.

A93-27132

THE NATIONAL PLAN FOR AVIATION HUMAN FACTORS - MAINTENANCE RESEARCH ISSUES

WILLIAM B. JOHNSON (Galaxy Scientific Corp., Atlanta, GA) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 28-32. Research sponsored by FAA refs

Copyright

The National Plan for Aviation Human Factors addresses Human Factors research associated with pilots, controllers, maintenance technicians, and their respective work environments. In each of the sections the plan addresses issues related to topics such as automation and advanced technology, basic scientific knowledge about human performance, information transfer, performance measurement, training and selection, and certification. This paper describes the portions of the National Plan related to maintenance.

01 AERONAUTICS (GENERAL)

It includes discussion of problems shared in the maintenance of aircraft and in the maintenance of the 'electronic highways' called airway facilities. The paper describes the Plan's research recommendations. In addition the paper elaborates on the current Office of Aviation Medicine Human Factors in Aviation Maintenance research, associated with the National Aging Aircraft Research Program. Author

A93-27134

ONGOING AND PLANNED R&D EFFORTS IN AIRWAY FACILITIES MAINTENANCE

DARYLE J. GARDNER-BONNEAU (CTA, Inc., McKee City, NJ) and JOHN L. WILEY (FAA Technical Center, Pomona, NJ) / In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 37-41.

Copyright

Airway facilities maintenance has been a neglected area of human factors R&D until recently. The National Plan for Aviation Human Factors, however, specifically mandates that the needs of aircraft and airway facility maintainers, as well as pilots and controllers, be addressed in the design and operation of new systems. The purpose of this paper is to outline the major research issues within the area of airway facilities maintenance, and to describe some of the Federal Aviation Administration's ongoing efforts to address these issues. Author

A93-28396

EAST EUROPE'S AIRCRAFT BUILDERS LOOK WEST

PHILIP BUTTERWORTH-HAYES Aerospace America (ISSN 0740-722X) vol. 31, no. 3 March 1993 p. 34-37.

Copyright

A survey is presented of current efforts of major aerospace design and manufacturing enterprises of the former USSR to market both their military and civilian aircraft. These enterprises encompass such giants as Tupolev, Mikoyan-Gurevich, Yakovlev, Sukhoi, and Ilyushin. It is noted that airliners such as the Tu-204, when reengineered with Western powerplants, will yield performance levels comparable to those of B757-generation airliners but at 25 percent lower initial cost. Attention is also given to East European aerospace enterprises and the ex-Soviet spacecraft and launch vehicle industries and infrastructures. O.C.

A93-28874

HELICOPTERS - HANDBOOK [VERTOLETY - SPRAVOCHNIK]

A. M. VOLODKO, M. P. VERKHOZIN, and V. A. GORSHKOV Moscow Voennoe Izdatel'stvo 1992 557 p. In Russian. (ISBN 5-203-00804-3) Copyright

Fundamental reference data are presented on the aerodynamics, flight dynamics, design, equipment, and operation and maintenance of single-rotor and coaxial helicopters. In particular, the book covers the aerodynamics and dynamics of the rotor blades, stability and maneuverability of helicopters, takeoff and landing, and flight emergencies. Descriptions of the general design and technical maintenance data are presented for the main helicopter systems and components, including the main and tail rotors, control system, airframe components, powerplant, electrical equipment, instrumentation and oxygen equipment, radio communication equipment, and piloting and navigation systems. V.L.

A93-29130

RACE PULLS FOR SHARED CONTROL

M. B. LEAHY, JR. and B. K. CASSIDAY (USAF, San Antonio Air Logistics Center, Kelly AFB, TX) / In Cooperative intelligent robotics in space III; Proceedings of the Meeting, Boston, MA, Nov. 16-18, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 341-350. refs

Copyright

The paper presents an overview of the RACE (Robotics and Automation Center of Excellence) internal initiatives and customer support, with particular emphasis on production processes that will benefit from shared-control technology. The RACE mission

objective is to promote the development and judicious insertion of the robotics and automation technologies necessary to enhance the competitive posture of the Air Logistic Center product directorates. RACE project areas include large aircraft systems, industrial automation, retrofits, and telerobotics. P.D.

A93-29473

COMPETITION IN A SINGLE EUROPEAN AIR TRANSPORT MARKET; PROCEEDINGS OF THE CONFERENCE, LONDON, UNITED KINGDOM, DEC. 1, 1992

London Royal Aeronautical Society 1992 72 p.

(ISBN 1-85768-080-4) Copyright

The present conference on the inter-European air transport market discusses the status of efforts toward internal market goals, the EC commission's post-1992 activities and initiatives, prospective structural changes in the air transport sector, the character and consequence of EC licensing rules, and an economist's views on fair-competition rules. Also discussed is the EC commission's control of airline mergers, the creation of a European Aviation Authority, consumer expectations of airline competition and choice, flags and carriers of convenience in a single European air transport market, and charter airline operations in a liberalized European market. (No individual items are abstracted in this volume) O.C.

A93-29475

AIR TRANSPORT GROWTH - HOW WILL AIRPORTS MANAGE?; PROCEEDINGS OF THE CONFERENCE, LONDON, UNITED KINGDOM, OCT. 21, 1992

London Royal Aeronautical Society 1992 72 p.

(ISBN 1-85768-065-0) Copyright

The present conference on the dependency of air transport expansion on the availability of airport development resources discusses the planning and implementation of facilities, services, and procedures at international airports, the financing of airport development, and the relationship of airlines to the environment. Also discussed is the facilitation of airport expansion in the UK, access to airports by road and rail within an integrated transport system, access to airports and within airport environments, and the incorporation of security measures into airport development. (No individual items are abstracted in this volume) O.C.

N93-19976*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RAREFIED-FLOW SHUTTLE AERODYNAMICS MODEL

ROBERT C. BLANCHARD, KEVIN T. LARMAN (Lockheed Engineering and Sciences Co., Hampton, VA.), and CHRISTINA D. MOATS (Lockheed Engineering and Sciences Co., Hampton, VA.) Feb. 1993 26 p

(Contract RTOP 506-48-11-04)

(NASA-TM-107698; NAS 1.15:107698) Avail: CASI HC A03/MF A01

A rarefied-flow shuttle aerodynamic model spanning the hypersonic continuum to the free molecule-flow regime was formulated. The model development has evolved from the High Resolution Accelerometer Package (HiRAP) experiment conducted on the Orbiter since 1983. The complete model is described in detail. The model includes normal and axial hypersonic continuum coefficient equations as functions of angle-of-attack, body flap deflection, and elevon deflection. Normal and axial free molecule flow coefficient equations as a function of angle-of-attack are presented, along with flight derived rarefied-flow transition bridging formulae. Comparisons are made with data from the Operational Aerodynamic Design Data Book (OADDB), applicable wind-tunnel data, and recent flight data from STS-35 and STS-40. The flight-derived model aerodynamic force coefficient ratio is in good agreement with the wind-tunnel data and predicts the flight measured force coefficient ratios on STS-35 and STS-40. The model is not, however, in good agreement with the OADDB. But, the current OADDB does not predict the flight data force coefficient ratios of either STS-35 or STS-40 as accurately as the flight-derived model. Also, the OADDB differs with the wind-tunnel force coefficient ratio data. Author (revised)

N93-20902*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE 1992 RESEARCH/TECHNOLOGY REPORT

1992 172 p

(NASA-TM-105924; E-7425; NAS 1.15:105924) Avail: CASI HC A08/MF A02

The 1992 Research & Technology report is organized so that a broad cross section of the community can readily use it. A short introductory paragraph begins each article and will prove to be an invaluable reference tool for the layperson. The approximately 200 articles summarize the progress made during the year in various technical areas and portray the technical and administrative support associated with Lewis technology programs. Author (revised)

N93-21342# Engineering and Economics Research, Inc., Vienna, VA.

POLAND CIVIL AVIATION MASTER PLAN AND INVESTMENT PROGRAM: EXECUTIVE SUMMARY

1 Jan. 1992 61 p Sponsored by Trade and Development Program

(PB92-213685) Avail: CASI HC A04/MF A01

A study of Poland's airport and airspace systems, including reviews of the Governmental organizational structure supporting aviation and the financial components which seek to support operation of the systems, was conducted. The result of the study is the Civil Aviation Master Plan for Poland. The Executive Summary covers the key findings and most significant project recommendations which need to be implemented to modernize Poland's airport and airspace systems including the organizational and financial support components. The Master Plan also contains an Investment Program which recommends how to finance the needed changes and improvements. It begins by summarizing the aviation forecasts and key findings. It then presents an overview of requirements and recommendations, the Capital Investment Plan, and a summary of the training accomplished during the contract and future training needs. GRA

N93-21343# Engineering and Economics Research, Inc., Vienna, VA.

POLAND CIVIL AVIATION MASTER PLAN AND INVESTMENT PROGRAM Final Report

Jan. 1992 199 p Sponsored by Trade and Development Program

(PB92-213693) Avail: CASI HC A09/MF A03

The Government of Poland and the United States Trade and Development Program (TDP) reached an agreement in mid-1990 through which the TDP provided a grant to Poland for developing a Civil Aviation Master Plan and Investment Program for the 1992-2005 timeframe. The general scope of the work included: development of forecasts for growth; a review of selected airports throughout Poland; a review of the existing airspace system, including air traffic control (ATC), airspace structure and management, navigation systems, communications systems; an institutional and review of the General Inspectorate of Civil Aviation (GILC) and the Polish Airports State Enterprise (PPL); a review of the PPL financial operations and tariff structure and the development of a financial model; and development of a Civil Aviation Master Plan, including an Investment Program. GRA

N93-21713# CORE International, Inc., Washington, DC.

DEFINITIONAL MISSION FOR CIVIL AVIATION MASTER PLAN FOR POLAND

VINOD K. SHRIVASTAVA and JAMES R. BANKS Jun. 1990 35 p Sponsored by Trade and Development Program

(PB92-213974) Avail: CASI HC A03/MF A01

A definitional mission was conducted to investigate Poland's airport and airspace systems, including reviews of the governmental organizational structure supporting aviation and the financial components which seek to support operation of the systems. An overview of the existing system, an assessment of requirements, and the mission's recommendations are presented.

Author (revised)

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A93-23778

INVESTIGATION ON BI-FLAT JET SEPARATED FLOW IN A RECTANGULAR COMBUSTOR

JING-BIN WEI (Chinese Academy of Sciences, Inst. of Mechanics, Beijing, China) *In* Laser anemometry - Advances and applications 1991; Proceedings of the 4th International Conference, Cleveland, OH, Aug. 5-9, 1991. Vol. 1 New York American Society of Mechanical Engineers 1991 p. 11-15. Research supported by Orient Foundation of Portugal refs

Copyright

A new type of combustion aerodynamics with bi-flat inlet jets is described. The flowfields of a combustor model are measured using laser Doppler velocimetry. It is shown that the combustor aerodynamics is characterized by a large central recirculation zone and high turbulent intensity. The high mean velocity layers are located near the walls in the middle section of the combustor. The higher turbulent velocity values are located at the zero mean velocities. V.L.

A93-23807

A LASER DOPPLER ANEMOMETRY STUDY OF A SUPERSONIC JET IN A LOW SPEED CROSS-FLOW

XIN ZHANG and DAVID W. HURST (Southampton Univ., United Kingdom) *In* Laser anemometry - Advances and applications 1991; Proceedings of the 4th International Conference, Cleveland, OH, Aug. 5-9, 1991. Vol. 2 New York American Society of Mechanical Engineers 1991 p. 403-411. Research sponsored by Royal Aerospace Establishment refs

Copyright

A Laser Doppler Anemometry study is presented on supersonic jet/low speed cross-flow interactions. The supersonic jet/low speed cross-flow interactions are produced by introducing jets of various pressure ratios into a low speed cross-flow. The jets are generated by a Mach 1.4 convergent-divergent nozzle. Both time-mean and statistical characteristics of the flow are studied. The study shows flow entrainment induced by the jet and a significant increase in the jet plume size. Large scale changes in the direction and the magnitude of the flow are observed. After the initial stage of the jet development, a significant increase in the turbulent mixing level is noticed. The jet center lines is found to bend faster toward the cross-flow direction than that of a low speed jet at the same effective velocity ratio. Author

A93-23811* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SEED PARTICLE RESPONSE AND SIZE CHARACTERIZATION IN HIGH SPEED FLOWS

ROGER C. RUDOFF and WILLIAM D. BACHALO (Aerometrics, Inc., Sunnyvale, CA) *In* Laser anemometry - Advances and applications 1991; Proceedings of the 4th International Conference, Cleveland, OH, Aug. 5-9, 1991. Vol. 2 New York American Society of Mechanical Engineers 1991 p. 443-447. refs

(Contract NAS2-13286; NAS2-13300)

Copyright

The response of seed particles ranging between 0.7 and 8.7 micron is determined using a phase Doppler particle analyzer which simultaneously measures particle size and velocity. The stagnant seed particles are entrained into a high speed free jet at velocities ranging from 40 to 300 m/s. The size-mean axial velocity correlation and size-rms velocity correlations are used to determine the particle response to the sudden acceleration. It was determined that at the lower speeds, seed particles up to approximately 5 microns are adequate, but as velocities approach 300 m/s only particles on the order of one micron are suitable. The ability to determine

size and velocity simultaneously is essential if seeding with polydispersions is used since it allows the rejection of data which will not accurately represent the flow field. Author

A93-23838

MULTI-BLOCK GRID GENERATION FOR COMPLETE AIRCRAFT CONFIGURATIONS

P. PIPERNI, F. MOKHTARIAN, and F. KAFYEKE (Canadaair, Aerospace Group, Montreal, Canada) Canadian Aeronautics and Space Journal (ISSN 0008-2821) vol. 38, no. 4 Dec. 1992 p. 144-155. Research supported by Defence Industrial Research Program of Canada refs

A multi-block grid generation capability has been developed recently at Canadaair to construct body-fitted grids over full aircraft configurations. This paper describes the main features of the methodology employed in the grid generation procedure, including a discussion of the mathematical formulation implemented in the grid generation programs, a description of the multi-blocking strategy adopted, and a discussion of the domain decomposition technique and automated CAD interface. Sample grids are presented for the Challenger CL-601 aircraft, including a modelling of the winglets and the double-flux engine nacelle. Author

A93-24076

NATIONAL CONFERENCE ON AERODYNAMICS, 6TH, BANGALORE, INDIA, SEPT. 1992, PROCEEDINGS

Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 133 p.

The present volume on aerodynamics discusses an acoustic flux vector splitting scheme for Euler equations, numerical modeling of leading edge separated flow at incompressible speeds, a 2D explicit inviscid upwind code for convergent divergent nozzles, and the generation of data for blade sections of wind energy systems. Attention is given to an aerodynamically efficient wing design with structural considerations, the numerical computation of viscous hypersonic flow around spherically blunted cones at angle of attack, a Navier Stokes simulation of vortex shedding from a square cylinder in an unconfined domain, and an implicit finite difference algorithm for a 2D Euler equation. Topics addressed include numerical experiments in 1D Euler equations using higher-order schemes, a numerical simulation of the oscillations of a square prism in a fluid flow, an upwind formulation for the solution of thin-layer Navier-Stokes equations, and experiments on rarefied supersonic free jets using impact probes. (For individual items see A93-24077 to A93-24091) C.A.B.

A93-24078

ACOUSTIC FLUX VECTOR SPLITTING SCHEME FOR EULER EQUATIONS

N. BALAKRISHNAN and S. M. DESHPANDE (Indian Inst. of Science, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 161-164. refs

Copyright

The wave motion and particle motion of inviscid fluids are employed to construct a new numerical scheme for solving Euler equations. The novel scheme is applied for solving the 1D shock tube problem and the flow past a ramp in a channel. C.A.B.

A93-24079

NUMERICAL MODELING OF LEADING EDGE SEPARATED FLOW AT INCOMPRESSIBLE SPEEDS

A. K. BHATTACHARYA and N. L. ARORA (Indian Inst. of Technology, Kanpur, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 165-170. refs

Copyright

Consideration is given to a numerical technique for modeling the leading edge separated flow past thin delta wings at moderate to high angles of attack. This technique is based on a panel method assuming constant doublet strengths on flat panels that discretize surfaces of thin wings and vortex sheets. The present

method employs low-order panels, which simplifies the problem considerably while yielding comparable results. C.A.B.

A93-24080

NOZZ2D - A TWO DIMENSIONAL EXPLICIT INVISCID UPWIND CODE FOR CONVERGENT DIVERGENT NOZZLES

DEVESH VERMA (Indian Inst. of Technology, Kharagpur, India) and BIJU UTHUP (Aeronautical Development Agency, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 171-179. refs

Copyright

The study presents a 2D finite volume upwind code for solving the unsteady Euler equation for a 2D convergent divergent nozzle. The upwind code, NOZZ2D, is based on the flux vector splitting scheme of Van Leer (1982) with MUSCL differencing. The grid in the nozzle is generated by transfinite interpolation. In general, the shock location and shape predicted by NOZZ2D agrees very well with the Navier-Stokes prediction. When the wall pressure distribution is compared with experiments, NOZZ2D predicts shock further downstream. It is concluded that this deficiency can be removed by including the region external to the nozzle in the computational domain and placing the outer boundary of this external region very far from the exit of the nozzle. C.A.B.

A93-24081

AERODYNAMICALLY EFFICIENT WING DESIGN WITH STRUCTURAL CONSIDERATIONS

S. C. GUPTA (Defence Research Development Organisation, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 189-193. refs

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The cambered wing details that result in maximum lift-drag ratios and provide peak pressure difference loadings around desired chordwise locations, which are restricted due to structural reasons, are examined. These designs result in significant wing warp and are, therefore, of utility for aircraft operating close to one such design condition. Practical application of this design exercise is limited to high performance transport planes. Design details are elaborated for a large aspect ratio wing for subsonic flow conditions. The design evaluation of the wing planform, pressure distribution details, and optimal warp with and without peak loading spacing are illustrated in diagrams and graphs. C.A.B.

A93-24082

NUMERICAL COMPUTATION OF VISCOUS HYPERSONIC FLOW AROUND SPHERICALLY BLUNTED CONES AT ANGLE OF ATTACK

V. K. KUMAR (Aeronautical Development Establishment, Bangalore, India) and A. K. SREEKANTH (Indian Inst. of Technology, Madras, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 195-204. refs

Copyright

The study presents a 3D code for computing the viscous hypersonic flowfield around spherically blunted cones at angle of attack. Time-dependent viscous shock layer equations are used to describe the flowfield. MacCormack's (1982) two-step finite difference scheme is used to arrest the oscillations in the flow variables during the computations to ensure convergence. Results are presented for 0- and 10-deg angles of attack in helium at Mach numbers 14.9 and 20.3, respectively. Findings compare well with the available experimental results. A set of results for 5-deg angle of attack in air at a Mach number of 10.33 is obtained and compared with the existing numerical results, and they are found to be in good agreement. C.A.B.

A93-24083

A TWO-DIMENSIONAL ELLIPTIC GRID GENERATOR FOR A WING-BODY SECTION INVOLVING GRID CONTROL FUNCTIONS

R. KRISHNAMURTHY, M. NAGARATHINAM, S. SEKAR, and P. K. SINHA (Defence Research and Development Lab., Hyderabad,

India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 205-208. refs
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An elliptic grid generator code for generating a 2D elliptic grid for a wing-body section was developed. The code was implemented in the DRDL 386/486 systems along with the associated graphics for grid visualization. Control over the grid is exercised by assigning values to the two control functions which appear in the governing partial differential equations by a trial-and-error method. The grid obtained is smooth and continuous. The effects of the control functions on the behavior of the grid lines are examined. This method can be highly useful in the generation of quasi-3D elliptic grids for lifting-surface dominated configurations like missiles by stacking the 2D grids developed from different cross sections.

C.A.B.

A93-24085

AN IMPLICIT FINITE DIFFERENCE ALGORITHM FOR TWO DIMENSIONAL EULER EQUATION

K. M. KRISHNA (Aeronautical Development Agency, Bangalore, India) and N. R. SUBRAMANIAM (National Aeronautical Lab., Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 215-220. refs
Copyright

Preliminary calculations of 2D flows around arbitrary bodies obtained via an implicit finite difference algorithm for Euler equations in conservation law form are presented. To accelerate the convergence rate, a spatially varying time step based on the grid geometry represented by the jacobian of the transformation is incorporated. A circular cylinder calculation using a stretched polar grid for $M_\infty = 0.45$, $\alpha = 0$ deg (inviscid), and $M_\infty = 0.2$, $\alpha = 0$ deg, and $Re = 40$ (viscous laminar) is carried out. The flow over the NACA 0012 using O-grid for $M_\infty = 0.63$ and 0.75 , $\alpha = 0$ deg and 2 deg (inviscid) is also determined.

C.A.B.

A93-24088

AN UPWIND FORMULATION FOR THE SOLUTION OF THIN-LAYER NAVIER-STOKES EQUATIONS

S. K. SAXENA (National Aeronautical Lab., Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 253-257. refs
Copyright

High-speed viscous flows are numerically simulated using solutions of thin-layer Navier-Stokes equations in a generalized body-fitted coordinate system and a nondimensional form. A second-order accurate upwind MUSCL-type algorithm incorporating a flux-vector splitting method developed by Van Leer is formulated within the framework of the finite volume approach. TVD limiters are used to avert undershoots and overshoots in the shock region. Results of laminar flow calculations are presented for a hemisphere cylinder configuration at supersonic Mach number. The Van Leer flux-splitting used in the flow solver to handle inviscid terms through an upwinding procedure provides reasonably good simulation of high-speed viscous flows. The shock is captured crisply with no artificial dissipation added.

C.A.B.

A93-24089

INCOMPRESSIBLE POTENTIAL FLOW CALCULATION ABOUT HARMONICALLY OSCILLATING THREE-DIMENSIONAL CONFIGURATIONS

N. SINGH and K. P. SINHMAHAPATRA (Indian Inst. of Technology, Kharagpur, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 259-264. refs
Copyright

Unsteady pressure and lift distributions on the harmonically oscillating wing-fuselage-tiptank and wind-fuselage-pylon-store configurations in an incompressible flow are calculated with a numerical method based on the internal singularity distribution technique. Source and vorticity singularities are distributed on the mean camber surface on the wing, while the fuselage and other nonlifting bodies carry a source distribution on their wetted surface. The presence of the tiptank is found to affect the in-phase

component significantly. When mounted on a pylon, the external store has a small effect localized at the wing-pylon junction but on the in-phase and out-of-phase components.

C.A.B.

A93-24090

THREE-DIMENSIONAL FLOW SIMULATION OVER AXISYMMETRIC BODIES USING NAVIER-STOKES EQUATIONS AT HYPERSONIC MACH NUMBERS

SREEKANTH and N. M. REDDY (Indian Inst. of Science, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 265-279. refs
Copyright

The study presents 3D laminar flow calculations for axisymmetric bodies. The governing equations are derived in a body-fitted coordinate system. The explicit MacCormac's (1982) scheme is used to solve the system of equations. Results are presented for three cases: flow over a blunt cone at angle of attack, flow over the cone-cylinder junction, and flow over the spherical nose tip. The results for flow over a blunt cone for a freestream Mach number of 10.6 are compared with the available PNS solutions, and they agree very well. Problems encountered in the case of flow over the cone-cylinder junction and the spherical nose tip are discussed. It is suggested that a fairly reasonable initial guess of the wall pressure is required for the cone cylinder case.

C.A.B.

A93-24091

EXPERIMENTS ON RAREFIED SUPERSONIC FREE JETS USING IMPACT PROBES

A. K. SREEKANTH and CHANNA RAJU (Indian Inst. of Technology, Madras, India) Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 281-284. refs
Copyright

An experimental investigation on supersonic rarefied free jets which employs two types of probes is reported. The externally chamfered conventional open ended impact probe has very large viscous corrections at low Reynolds number, and the second probe is of a new type that is claimed to be free of viscous effects and degree of rarefaction. The jets from a 6.75-mm diameter circular orifice and a rectangular slit of $l/w = 10$ are studied, and the results are compared with the available literature. It is shown that the second probe, which is insensitive to Reynolds number effects, performs well in a low-density supersonic stream.

C.A.B.

A93-24233*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THREE-DIMENSIONAL UNSTRUCTURED GRID EULER METHOD APPLIED TO TURBINE BLADES

OH J. KWON (Sverdrup Technology, Inc., Brook Park, OH) and CHUNILL HAH (NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0196)

Flow through a turbine annular cascade is calculated using a three-dimensional Euler method based on unstructured tetrahedral meshes. The equations are integrated in time using an explicit Runge-Kutta time-stepping scheme. The inviscid flux terms are discretized using a cell-centered finite-volume formulation with upwind flux-difference splitting. The tetrahedral meshes around the turbine blade are generated using an advancing-front technique with forced geometric periodicity between the blades. Good agreement is obtained between the present calculation and the experiment for both surface pressure distribution and flow behavior in the passage between the blades, demonstrating the capability of the present methodology for turbomachinery flow applications.

Author

A93-24238*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DRIVEN CAVITY SIMULATION OF TURBOMACHINE BLADE FLOWS WITH VORTEX CONTROL

M. M. ATHAVALE, A. J. PRZEKAS (CFD Research Corp., Huntsville, AL), and R. C. HENDRICKS (NASA, Lewis Research

Center, Cleveland, OH) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0390) Copyright

This paper presents a computational study of the three-dimensional flows in a rotating cavity with clearance between cavity walls and lid wall. The objectives of this study is to understand the interaction mechanism between tip leakage and blade passage flows and to assess the means to control the flow pattern and pressure losses. The classes of problems addressed include: passage geometry, passage loading including lid velocity and anti-vortex strength, and placement necessary to provide flow control. The computational model is first validated on generic flow problems and then applied to a specific blade passage configuration. Results of parametric studies for secondary flow pattern control are analyzed, and practical means of vortex control are discussed. Author

A93-24240*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THREE-DIMENSIONAL NAVIER-STOKES CALCULATIONS USING SOLUTION-ADAPTED GRIDS

T. L. HENDERSON, W. HUANG, K. D. LEE (Illinois Univ., Urbana), and Y. K. CHOO (NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 14 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0431) Copyright

A three-dimensional solution-adaptive grid generation technique is presented. The adaptation technique redistributes grid points to improve the accuracy of a flow solution without increasing the number of grid points. It is applicable to structured grids with a multiblock topology. The method uses a numerical mapping and potential theory to modify the initial grid distribution based on the properties of the flow solution on the initial grid. The technique is demonstrated with two examples - a transonic finite wing and a supersonic blunt fin. The advantages are shown by comparing flow solutions on the adapted grids with those on the initial grids. Author

A93-24294#

COMPARISON OF EXPERIMENTAL GROUND TESTING AND COMPUTATIONAL FLUID DYNAMICS FOR THE RE-ENGINEED 727-100 CENTER ENGINE INLET

ANDREW P. SLATER, PAO S. HUANG, A. PASCHAL (Dee Howard Co., San Antonio, TX), and CLARE BEWICK (Rolls-Royce, PLC, Derby, United Kingdom) Jul. 1992 9 p. AIAA, Aerospace Ground Testing Conference, 17th, Nashville, TN, July 6-8, 1992 refs

(AIAA PAPER 92-3920) Copyright

This paper discusses the correlation that was achieved between predicted airflow qualities determined using computational fluid dynamics (CFD), and results achieved from a full scale instrumented ground test of a redesigned center engine inlet (S-duct) for the reengineed Boeing 727-100 with Rolls-Royce Tay 651 engines. Results are presented by comparisons of static pressure distributions, inlet distortion and total pressure losses. Author

A93-24308

EXACT-GRADIENT SHAPE OPTIMIZATION OF A 2-D EULER FLOW

FRANCOIS BEUX and ALAIN DERVIEUX (INRIA, Valbonne, France) Finite Elements in Analysis and Design (ISSN 0168-874X) vol. 12, no. 3-4 Dec. 1992 p. 281-302. Research supported by BRITE/EURAM refs Copyright

The optimization of an obstacle shape immersed in an Eulerian flow is investigated. In order to construct a descent method, we consider the differentiation of the flow solution with respect to the shape. In the continuous case, the Hadamard variational formula yields the formal derivatives. In the discrete case, we choose an upwind method with flux splitting, and prove that an exact gradient can be derived using the adjoint state. The behavior of a gradient method is studied for a family of nozzle flows. Author

A93-24409

THE ASYMPTOTIC THEORY OF HYPERSONIC BOUNDARY-LAYER STABILITY

S. E. GRUBIN and V. N. TRIGUB (TsAGI, Zhukovskii, Russia; INTECO, Frosinone, Italy) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 246 Jan. 1993 p. 361-380. Research supported by INTECO refs Copyright

The theory of the linear stability of the hypersonic boundary layer is formulated for the vorticity mode at freestream Mach number approaching infinity in the local-parallel approximation. The problem is solved numerically with the aid of the spectral method. The universal upper branch of the neutral curve is obtained and compared with the numerical results for the complete problem. The main features of the vorticity mode in the limit freestream Mach number approaching infinity are assigned and discussed. I.S.

A93-24410

THE LONG-WAVE LIMIT IN THE ASYMPTOTIC THEORY OF HYPERSONIC BOUNDARY-LAYER STABILITY

S. E. GRUBIN and V. N. TRIGUB (TsAGI, Zhukovskii, Russia; INTECO, Frosinone, Italy) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 246 Jan. 1993 p. 381-395. Research supported by INTECO refs Copyright

This paper discusses the long-wave limit of the asymptotic theory of hypersonic boundary-layer stability for a gas with the Prandtl number sigma between values of 1/2 and 1 and with the viscosity-temperature law being a power function. The investigation is confined to the local-parallel approximation. In the long-wave limit, the vorticity mode starts to interact with the acoustic disturbances in the boundary-layer region. The general solution of the linear problem in the boundary-layer inner region is analyzed numerically and analytically. This solution is matched with the long-wave vorticity-mode solution near the transition layer. As a result, the inviscid instability problem for a hypersonic boundary layer is formulated. The analytical solution of this problem is found and analyzed. The different limits of the solution are considered and the universal forms of the dependence are obtained. A similarity parameter is found which is a function of the Prandtl number and the power in the viscosity-temperature law. Author

A93-24488*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DEVELOPMENT OF THE NASA-AMES LOW DISTURBANCE SUPERSONIC WIND TUNNEL FOR TRANSITION RESEARCH UP TO MACH 2.5

STEPHEN W. D. WOLF, JAMES A. LAUB, LYNDELL S. KING, and DANIEL C. REDA (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 11 p. AIAA, Aerospace Ground Testing Conference, 17th, Nashville, TN, July 6-8, 1992 refs (AIAA PAPER 92-3909)

A unique, low-disturbance supersonic wind tunnel is being developed at NASA-Ames to support supersonic laminar flow control research at cruise Mach numbers of the High Speed Civil Transport (HSCT). The distinctive aerodynamic features of this new quiet tunnel will be a low-disturbance settling chamber, laminar boundary layers on the nozzle walls and steady supersonic diffuser flow. Furthermore, this new wind tunnel will operate continuously at uniquely low compression ratios (less than unity). This feature allows an existing non-specialist compressor to be used as a major part of the drive system. In this paper, we highlight activities associated with drive system development, the establishment of natural laminar flow on the test section walls, and instrumentation development for transition detection. Experimental results from an 1/8th-scale model of the supersonic wind tunnel are presented and discussed in association with theoretical predictions. Plans are progressing to build the full-scale wind tunnel by the end of 1993. Author

A93-24489#

THE EFFECT OF REYNOLD'S NUMBER ON A NATURAL LOW FREQUENCY FLOW OSCILLATION OVER AN AIRFOIL NEAR STALL

D. C. HEINRICH (Illinois Univ., Urbana) Jul. 1992 9 p. AIAA, Aerospace Ground Testing Conference, 17th, Nashville, TN, July 6-8, 1992 refs

(AIAA PAPER 92-4040) Copyright

A relatively low frequency flow oscillation has been observed by Zaman (1987, 1988, 1989) at angles of attack near stall for certain airfoils. Zaman's study explored this phenomenon for Reynold's numbers less than 3.0×10^5 . This value is low in terms of most aerodynamic applications, and therefore, it is of interest to explore the effect of increasing Reynold's number above 3.0×10^5 on the flow oscillation. In doing this, Zaman's data will be verified and the persistence of the phenomenon with higher Reynold's numbers will be explored.

Author

A93-24493*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SOME EFFECTS OF WING AND BODY GEOMETRY ON THE AERODYNAMIC CHARACTERISTICS OF CONFIGURATIONS DESIGNED FOR HIGH SUPERSONIC MACH NUMBERS

M. L. SPEARMAN (NASA, Langley Research Center, Hampton, VA), DAVID C. TICE (Lockheed Engineering and Sciences Co., Hampton, VA), and DOROTHY O. BRASWELL (NASA, Langley Research Center, Hampton, VA) Aug. 1992 10 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs

(AIAA PAPER 92-4246) Copyright

Experimental and theoretical results are presented for a family of aerodynamic configurations for flight Mach numbers as high as Mach 8. All of these generic configurations involved 70-deg sweep delta planform wings of three different areas and three fuselage shapes with circular-to-elliptical cross sections. It is noted that fuselage ellipticity enhances lift-curve slope and maximum L/D, while decreasing static longitudinal stability (especially with smaller wing areas).

O.C.

A93-24524

A STUDY OF AERODYNAMIC PERFORMANCE OF A CONTRA-ROTATING AXIAL COMPRESSOR STAGE

D. S. PUNDHIR and P. B. SHARMA (Indian Inst. of Technology, New Delhi, India) Defence Science Journal (ISSN 0011-748X) vol. 42, no. 3 July 1992 p. 191-199. Research supported by Aeronautics Research and Development Board of India refs Copyright

This article presents an experimental investigation into the effect of speed ratio and axial spacing between contrarotors on the aerodynamic performance of a contrastage. The traverses of flow structure and pressure variation are examined at upstream and downstream of the first and the second rotor to illustrate the effect of speed ratio and axial spacing on the aerodynamic performance. The traverse results are analyzed to obtain relative total head loss and blade element efficiency of the contrarotors. The study reveals that the aerodynamics of a contrastage is significantly affected by the speed ratio as well as the axial spacing between contrarotors.

Author

A93-24672

A NUMERICAL METHOD FOR SOLVING NAVIER-STOKES EQUATIONS FOR LOW MACH NUMBER COMPRESSIBLE FLOWS

S. STANISIC and J. RYAN (ONERA, Chatillon, France) La Recherche Aeronautique (English Edition) (ISSN 0379-380X) no. 4 1992 p. 1-13. refs

Copyright

A finite difference method using a fractional step algorithm is developed to solve the 3D Navier-Stokes equations for low Mach number unsteady and compressible flows. To alleviate stability restrictions, which are severe when explicitly solving low Mach number flows, the original set of equations is replaced by a set of two systems of equations in which the acoustic waves have been

entirely transferred from the first system into the second. The first system is then solved explicitly with a time step depending only on the flow velocity while the second system is solved with a low cost implicit method. This method, validated by several numerical experiments, is compared to a semiimplicit algorithm used as reference to check the improvement in efficiency. For low Mach numbers of 3 or less, the proposed method allows a decrease in cost by a factor of up to 15. A first application is the comparison with a linear stability theory. A second application is the direct simulation of a compressible isothermal mixing layer at a Reynolds number of 400 and for a large range of Mach numbers from 0 to 0.7.

Author

A93-24752#

COMPARISON OF PMARC AND ANALYTIC RESULTS FOR TWO-DIMENSIONAL UNSTEADY AIRFOILS

DANIEL M. MARTIN (Sterling Software, Inc., Palo Alto, CA) and ILAN KROO (Stanford Univ., CA) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0636) Copyright

The Panel Method of the Ames Research Center (PMARC) code is presently used to predict the unsteady aerodynamics of airfoils undergoing sinusoidal pitching and plunging motion. Attention is given to the case of the section properties of a 100-aspect ratio wing model at midspan, which are compared to results obtained by thin-airfoil linear unsteady theory; emphasis is placed on results for the streamwise position of the vorticity shed closest to the trailing edge at each time-step. Plots of the phase-difference between PMARC results and those of the thin-airfoil equations as a function of frequency and time-step are presented.

O.C.

A93-24753#

DYNAMIC STALL ON A THREE-DIMENSIONAL RECTANGULAR WING

H. Q. YANG and A. J. PRZEKAS (CFD Research Corp., Huntsville, AL) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract F49620-91-C-0042)

(AIAA PAPER 93-0637) Copyright

The pressure-based Navier-Stokes equation solver, in the form of a high-order TVD scheme, is presently used to analyze steady and unsteady separating flows on a 3D rectangular wing, in both static and dynamic maneuvering cases. In addition to reproducing most experimentally observed flow features with good accuracy by these means, it is demonstrated that the wingtip vortex rollup suppresses the development of dynamic stall vortex and causes reduced lift, relative to the 2D airfoil.

O.C.

A93-24754#

NUMERICAL INVESTIGATIONS ON AIRFOIL PERFORMANCE SUBJECTED TO AERODYNAMIC INTERFERENCE FROM AN UPSTREAM AIRFOIL

SAN-YIH LIN and YUH-YING WANG (National Cheng Kung Univ., Tainan, Taiwan) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0639) Copyright

A finite element method for the solution of the time-dependent Euler equations is presented for unsteady aerodynamic analysis of NACA0012/NACA0010 airfoil involving structure dynamic grids, and extended to two-dimensional canard-wing aerodynamic interference. The spatial discretization involves the discontinuous Galerkin finite element method with Lax-Friedrichs flux method. The temporal discretization involves the explicit Runge-Kutta time-integration scheme. The unsteady oscillating NACA0012 airfoil problem is solved to demonstrate application of our solver, the unsteady results are obtained for the airfoil pitching harmonically about the quarter chord-length point. The resulting instantaneous pressure distributions, normal force coefficient, and moment coefficient during 4th cycle of motion are compared well with the numerical data introduced by Jameson et al. The later, we present

the results of two-dimensional canard-wing aerodynamic interference on steady and unsteady transonic flows. Author

A93-24756#**A MOVING MESH SYSTEM FOR THE CALCULATION OF UNSTEADY FLOWS**

ANN L. GAITONDE and S. P. FIDDES (Bristol Univ., United Kingdom) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by British Aerospace Airbus, Ltd refs (AIAA PAPER 93-0641) Copyright

A moving-mesh system for solving the Euler equations describing the compressible flow about an aerofoil undergoing arbitrary motions and deformations is described. A finite volume formulation is chosen where the volumes distort as the aerofoil moves. Independent motion of the inner and outer boundaries is permitted in the method, i.e., the grid is not constrained to move as a rigid body. It is shown that extra terms appear due to the motion of the aerofoil, and these have been evaluated and incorporated into the code. The issue of control of grid quality is discussed in the paper, and results from the application of the method to AGARD test cases are shown. The method gives good results in terms of detailed pressure distributions and load loops for unsteady flows. Author

A93-24758#**PILOT TEST OF A LOW REYNOLDS NUMBER DTE-AIRFOIL**

D. KOSS, S. BAUMINGER, M. SHEPSHELOVICH (Israel Aircraft Industries, Ltd., Tashan Engineering Center, Lod), A. SEIFERT, and I. WYGNANSKI (Tel Aviv Univ., Israel) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0643) Copyright

A divergent trailing edge (DTE) airfoil is presently theoretically analyzed and experimentally evaluated after geometrical definition, in order to assess its potential in high-lift/low Reynolds number applications. The well-tested PR7A airfoil was modified into the PR7D DTE-type. The intended performance was achieved by the DTE airfoil through the creation of a trailing-edge discontinuity that alleviates the airfoil's adverse pressure gradient. The level of drag at high lift coefficients is consistent with long-endurance flight, although there is excessive drag penalty at low and medium lift coefficients. O.C.

A93-24759#**DEVELOPMENT OF CIRCULATION CONTROL TECHNOLOGY FOR APPLICATION TO ADVANCED SUBSONIC TRANSPORT AIRCRAFT**

ROBERT J. ENGLAR, MARILYN J. SMITH, SEAN M. KELLEY, and RICHARD C. ROVER, III (Georgia Inst. of Technology, Atlanta) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0644) Copyright

An experimental/analytical research program was undertaken to develop advanced versions of Circulation Control Wing (CCW) airfoils and to address specific issues related to the application of these blown high-lift devices to subsonic transport aircraft. The program goal was to determine the feasibility and potential of these pneumatic configurations to increase high-lift system performance while reducing system complexity and aircraft noise in the terminal area. Experimental lift coefficient values approaching 8.0 at zero incidence were demonstrated; these were predicted to yield 70-80 percent reductions in takeoff and landing distances for an advanced subsonic transport configuration. These results and experimental/CFD methods will be presented in greater detail in the following discussions. Author

A93-24760*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NAVIER-STOKES COMPUTATIONS AND EXPERIMENTAL COMPARISONS FOR MULTIELEMENT AIRFOIL CONFIGURATIONS

W. K. ANDERSON and DARYL L. BONHAUS (NASA, Langley

Research Center, Hampton, VA) Jan. 1993 20 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0645) Copyright

A two-dimensional unstructured Navier-Stokes code is utilized for computing the flow around multielement configurations. Comparisons are shown for a landing configuration with an advanced-technology flap as well as for a takeoff configuration. For each, a grid convergence study is conducted to assess inaccuracies caused by inadequate grid resolution. Although adequate resolution is obtained for determining the pressure distributions, further refinement is needed to sufficiently resolve the velocity profiles at high angles of attack. For the advanced flap configuration, comparisons of pressure distributions and lift are made with experimental data. Here, two flap riggings and two Reynolds numbers are considered. In general, the trends caused by variations in these quantities are well predicted by the computations, although the angle of attack for maximum lift is overpredicted. For the takeoff configuration, comparisons between pressures, velocity profiles, and Reynolds stresses are made at a single angle of attack with generally good agreement. Author

A93-24761#**HYSTERESIS EFFECTS ON WIND TUNNEL MEASUREMENTS OF A TWO-ELEMENT AIRFOIL**

KASIM BIBER and GLEN W. ZUMWALT (Wichita State Univ., KS) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0646) Copyright

Wind tunnel tests were conducted on the GA(W)-2 airfoil with 25 percent slotted flap at Reynolds number 2.2×10^6 and Mach number of 0.13. The tests were made for flap-nested and -deflected cases of 30 and 40 deg with optimum and narrow gaps. Stall characteristics on the airfoil elements were examined through plots of force, moment and surface pressure data and flow visualization. Flap-deflected configurations indicated a two-stage stall and hysteresis phenomenon. The hysteresis loop appeared to be a function of flap angle, gap geometry, and history of changes in air speed or angle of attack. Author

A93-24762*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

LIFT ENHANCEMENT OF AN AIRFOIL USING A GURNEY FLAP AND VORTEX GENERATORS

BRUCE L. STORMS (Sterling Software, Inc.; NASA, Ames Research Center, Moffett Field, CA) and CORY S. JANG (California Polytechnic State Univ., San Luis Obispo) Jan. 1993 9 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0647) Copyright

The results of a low-speed wind tunnel test are presented for a single-element airfoil incorporating two lift-enhancing devices, namely a Gurney flap and vortex generators. The former consists of a small plate, on the order of one to two percent of the airfoil chord in height, located at the trailing edge perpendicular to the pressure side of the airfoil. The latter consist of commercially-available, wishbone-shaped vortex generators. The test was conducted in the NASA Ames 7- by 10-foot Wind Tunnel with a full-span NACA 4412 airfoil. Measurements of surface pressure distributions and wake profiles were made to determine the lift, drag, and pitching-moment coefficients for the various airfoil configurations. The results indicate that the addition of a Gurney flap increased the maximum lift coefficient from 1.49 up to 1.96. Author

A93-24763#**AIRFOIL DESIGN USING THE NAVIER-STOKES EQUATIONS**

S. EYI, J. O. HAGER, and K. D. LEE (Illinois Univ., Urbana) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0648) Copyright

A design optimization technique is presented which couples a computationally efficient Navier-Stokes code with a numerical

optimization algorithm. The design method improves the aerodynamic performance of an airfoil subject to specified design objectives and constraints. Recent advances in computers and computational fluid dynamics have permitted the use of the Navier-Stokes equations in the design procedure to include the nonlinear rotational viscous physics of transonic flows. The use of optimization guarantees that a better design will be produced even with strict design constraints. The method is demonstrated with several examples at transonic flow conditions. Author

A93-24764* # National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FUNDAMENTAL ISSUES IN SUBSONIC/TRANSONIC EXPANSION CORNER AERODYNAMICS

W. H. MASON (Virginia Polytechnic Inst. and State Univ., Blacksburg) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract NAG1-1098)

(AIAA PAPER 93-0649) Copyright

While the characteristics of subsonic/transonic expansion-corner aerodynamics are important in the design of subsonic high-lift devices, these must be optimized for transonic cruise and maneuvering flight. Attention is presently given to illustrative experimental examples of these flow phenomena; a flowfield model has been used as the basis of such flows' consideration, and computational examples are used to express these flows' essential features. O.C.

A93-24772#

A STUDY OF COMPRESSIBLE TURBULENCE

ROBERT E. CHILDS, DAVID NIXON, LAURENCE R. KEEFE, and LAURA C. RODMAN (Nielsen Engineering and Research, Inc., Mountain View, CA) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(Contract F49620-91-C-0037)

(AIAA PAPER 93-0659) Copyright

Theoretical analysis and large eddy simulation of the mixing layer at high convective Mach number are performed. Analysis indicates that turbulence is dominated by streamwise vortices as the Mach number approaches infinity. A conceptual model based on the assumption of swept vortices makes predictions about the sweep angle of these vortices from spanwise at low speeds to streamwise at high speeds, and about the reduced spreading rate at high speeds. In the flows considered, shocks are rare and weak, even at a convective Mach number of 2.5, because the flow normal to the swept vortices is subcritical. The turbulence energy is highly anisotropic with the streamwise energy being the largest component. The pressure-velocity correlations promote weak transfer of energy from the streamwise fluctuations to the other components of energy, and they strongly suppress the shear stress. Author

A93-24773#

COMPRESSIBLE TURBULENCE MEASUREMENTS IN A HIGH-SPEED HIGH REYNOLDS NUMBER MIXING LAYER

RODNEY D. W. BOWERSOX and JOSEPH A. SCHETZ (Virginia Polytechnic Inst. and State Univ., Blacksburg) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0660) Copyright

To assess the significant physics associated with compressible turbulence, extensive multiple overheat cross/normal-wire, shadowgraph image processing, and conventional probe surveys were obtained in a 2D supersonic free mixing layer, consisting of Mach 1.8 air injected tangentially into a Mach 4.0 freestream. A turbulence transformation was developed that allowed direct measurement of the total Reynolds shear stress. Profiles of 3D turbulent shear, apparent mass, and heat flux data were acquired. Compressibility accounted for 75 percent of the total Reynolds shear stress and 100 percent of the turbulent heat flux in the present nominally adiabatic flow. The incompressible models yielded results consistent with measured incompressible terms.

The Situ-Schetz techniques were generalized to consistently account for compressibility in all of the conservation equations. The performance of the new model was excellent. New compressible turbulent kinetic energy formulations were also developed. Author

A93-24774#

MEAN FLOWFIELD STRUCTURE OF A THREE-DIMENSIONAL SUPERSONIC TURBULENT BOUNDARY LAYER

W. KONRAD, A. J. SMITS (Princeton Univ., NJ), and D. KNIGHT (Rutgers Univ., New Brunswick, NJ) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by Rutgers Univ. and Princeton Univ. refs

(Contract AF-AFOSR-89-0033; AF-AFOSR-86-0266)

(AIAA PAPER 93-0661) Copyright

A detailed investigation is conducted of the mean flowfield of a 3D supersonic, turbulent boundary layer that is generated by isentropic compression, in view of both numerical and experimental data. The transverse and longitudinal pressure gradients are generated by a series of compression waves leading to a 20-deg turning of the freestream. The model proposed for the mean flowfield structure is compared with 3D shock wave/boundary layer interactions. O.C.

A93-24777#

THE EFFECT OF SHOCK MOTION ON ENTROPY PRODUCTION

DAVID NIXON (Belfast, Queen's Univ., United Kingdom) Jan. 1993 6 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0665) Copyright

A study is conducted of the effects of shock motion on entropy production through a normal shock wave in turbulent flow. It is established that while shock speed increases entropy production, the shock's ripple decreases it. Since both shock-speed and ripple are frequency-dependent, it appears possible to devise a mechanism for the reduction of wave drag through the creation of an oscillation in which the shock ripple dominates entropy production. O.C.

A93-24778#

HYBRID PRISMATIC/TETRAHEDRAL GRID GENERATION FOR COMPLEX 3-D GEOMETRIES

S. WARD and Y. KALLINDERIS (Texas Univ., Austin) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(Contract AF-AFOSR-91-0022)

(AIAA PAPER 93-0669) Copyright

The paper describes generation of hybrid prismatic/tetrahedral grids for complex 3D geometries. The method marches a triangular surface grid away from the body to form a semi-unstructured prismatic grid. Very thin elements are generated, which makes prisms most suitable to resolve viscous flow gradients. A special method generates the grid within the interface region between the prisms and tetrahedra. The resulting hybrid grid is suitable for performing Navier-stokes calculations in the prisms region near the body and Euler calculations in the tetrahedra region away from the body. Advantages of the developed method are its speed and its generality for treatment of 3D topologies. Author

A93-24786* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NAVIER-STOKES CALCULATIONS FOR THE UNSTEADY FLOWFIELD OF TURBOMACHINERY

JEN P. CHEN and DAVID L. WHITFIELD (Mississippi State Univ., Mississippi State) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(Contract NAG3-869)

(AIAA PAPER 93-0676) Copyright

The Multistage Unsteady Turbomachinery Code is presently used to numerically simulate the flowfield generated by rotating machinery. The code, which simplifies the Reynolds-averaged

Navier-Stokes equations via the thin-layer approximation, is an implicit finite-volume scheme with flux Jacobians that are evaluated by flux-vector splitting, while residual fluxes are evaluated by flux-difference splitting. Attention is given to the computational results this obtained for three engineering problems, involving propfan, rotating blade, and both rotating and static blade flows.

O.C.

A93-24787#

TWO-DIMENSIONAL NAVIER-STOKES ANALYSIS OF HIGH-LIFT MULTI-ELEMENT AIRFOILS USING THE Q-OMEGA TURBULENCE MODEL

KOICHI EGAMI, EIJI SHIMA, SHINGO NAKAMURA (Kawasaki Heavy Industries, Ltd., Kakamigahara, Japan), and KANICHI AMANO (Japan Aircraft Development Corp., Tokyo) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0679) Copyright

Two-dimensional Navier-Stokes flow calculations for multi-element high-lift devices were carried out. In order to calculate the aerodynamic characteristics at various angles of attack, the q-omega two-equation turbulence model was used. Numerical results showed the flow field with large viscous wake regions without flow separation on the upper surface of the flap at large angles of attack. For a three-element configuration, comparison with the Baldwin-Lomax model was also performed. In high Reynolds number cases of a four-element configuration, the numerical results indicated a decrease in lift coefficient adversely.

Author

A93-24788#

PRESSURE-BASED HIGH-ORDER TVD METHODOLOGY FOR DYNAMIC STALL SIMULATION

H. Q. YANG and A. J. PRZEKAS (CFD Research Corp., Huntsville, AL) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract F49620-91-C-0042) (AIAA PAPER 93-0680) Copyright

This paper presents a pressure-based methodology for solving 3D Navier-Stokes equations in both stationary and moving (body-conforming) coordinates. The discretization of convective terms by the presently developed high-order TVD schemes requires no artificial dissipation and can properly resolve the concentrated vortices in the wing-body with minimum numerical diffusion. Validation and demonstration studies showed the feasibility of using pressure-based TVD methodology for analyzing complicated flow structures associated with incompressible to highly compressible flows, and for revealing fluid physics associated with dynamic stall.

Author

A93-24818*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COMPARISON OF CONTINUUM AND PARTICLE SIMULATIONS OF EXPANDING RAREFIED FLOWS

FORREST E. LUMPKIN, III (NASA, Ames Research Center, Moffett Field, CA), IAIN D. BOYD, and ETHIRAJ VENKATAPATHY (Elort Inst., Palo Alto, CA) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0728) Copyright

Comparisons of Navier-Stokes solutions and particle simulations for a simple two-dimensional model problem at a succession of altitudes are performed in order to assess the importance of rarefaction effects on the base flow region. In addition, an attempt is made to include 'Burnett-type' extensions to the Navier-Stokes constitutive relations. The model geometry consists of a simple blunted wedge with a 0.425 meter nose radius, a 70 deg cone half angle, a 1.7 meter base length, and a rounded shoulder. The working gas is monatomic with a molecular weight and viscosity similar to air and was chosen to focus the study on the continuum and particle methodologies rather than the implementation of thermo-chemical modeling. Three cases are investigated, all at Mach 29, with densities corresponding to

altitudes of 92 km, 99 km, and 105 km. At the lowest altitude, Navier-Stokes solutions agree well with particle simulations. At the higher altitudes, the Navier-Stokes equations become less accurate. In particular, the Navier-Stokes equations and particle method predict substantially different flow turning angle in the wake near the after body. Attempts to achieve steady continuum solutions including 'Burnett-type' terms failed. Further research is required to determine whether the boundary conditions, the equations themselves, or other unknown causes led to this failure.

Author

A93-24830*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN EXPERIMENTAL PARAMETRIC STUDY OF GEOMETRIC, REYNOLDS NUMBER, AND RATIO OF SPECIFIC HEATS EFFECTS IN THREE-DIMENSIONAL SIDEWALL COMPRESSION SCRAMJET INLETS AT MACH 6

SCOTT D. HOLLAND and KELLY J. MURPHY (NASA, Langley Research Center, Hampton, VA) Jan. 1993 14 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0740) Copyright

The effects of the decrease in the ratio of specific heats have been investigated in generic 3D sidewall compression scramjet inlets with leading-edge sweep angles of 30 and 70 degrees. The effects of a decrease in ratio of specific heats were seen by comparing data from two facilities in two test gases: in the Langley Mach 6 CF4 Tunnel in tetrafluoromethane and in the Langley 15-Inch Mach 6 Air Tunnel in perfect gas air. In addition to the simulated real gas effects, the parametric effects of cowl position, contraction ratio, leading-edge sweep, and Reynolds number were investigated in the 15-Inch Mach 6 Air Tunnel. The models were instrumented with a total of 45 static pressure orifices distributed on the sidewalls and baseplate. Surface streamline patterns were examined via oil flow, and schlieren videos were made of the external flow field. The results of these tests have significant implications to ground based testing of inlets in facilities which do not operate at flight enthalpies.

Author

A93-24831#

AERODYNAMIC PERFORMANCE OF SCRAMJET INLET MODELS WITH A SINGLE STRUT

KOUICHIRO TAI, TAKESHI KANDA, KENJI KUDOU, ATSUO MURAKAMI, TOMOYUKI KOMURO, and KATSUHIRO ITOH (National Aerospace Lab., Kakuda Research Center, Japan) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0741) Copyright

A series of three dimensional side wall compression type scramjet inlet models with a single strut were tested in the Mach 4 wind tunnel to investigate the influence of the existence of the strut between the side walls. Fixing the shape of the side walls, five struts with the same width but different lengths were mounted, so that the each model could be compared with the same geometrical contraction ratio. The aerodynamic performances of inlets were determined by means of its total pressure efficiency and the mass capture ratio at the geometrical throat. Also, the flow visualizations were carried out to examine the flow structure inside the inlets. Some of the results were compared with those of the strutless models examined before. The additional shock waves generated by the strut created a large separation on the side walls, resulting in the reduction of the total pressure efficiency and the capture ratio.

Author

A93-24845#

VORTICAL SOLUTIONS IN SUPERSONIC CORNER FLOWS

R. MARSILIO (Torino, Politecnico, Turin, Italy) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by BRITE EURAM refs (AIAA PAPER 93-0760) Copyright

Vortical solutions for inviscid supersonic steady flows of conical internal corners are described using the steady state Euler equations and a numerical technique based upon a space-marching

procedure with a finite-volume approximation. The integration of the conservation laws makes it possible to accurately capture shocks and contact surfaces. The fluxes on the side walls of the volumes are calculated using a flux-difference splitting procedure based on the hyperbolicity of the Euler equations for steady hypersonic regimes. O.G.

A93-24846#
VORTEX DISTORTION DURING VORTEX-SURFACE INTERACTION IN A MACH 3 STREAM

IRAJ M. KALKHORAN (Polytechnic Univ., Brooklyn, NY) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0761) Copyright

An experimental study has been conducted in a Mach 3 stream to investigate supersonic vortex behavior upon interacting with a solid lifting surface placed in its passage. The experimental scheme involved positioning a two-dimensional wedge surface downstream of a slender semi-span vortex-generator wing section such that the generated trailing tip vortices interacted with the downstream wedge surface. The experimental setup was arranged so that interactions resulted in a close encounter of the vortex core and the wedge leading edge. Spark shadow photographs of the flow field along with chord-wise pressure measurements on the wedge surface was used to study the interaction problem. In their most organized form, distortion of stream-wise vortices upon interacting with the surface was found to result in formation of unsteady detached shock fronts followed by an apparent slip surface separating a subsonic region from a supersonic zone. The interaction was found to depend strongly on vortex strength and vortex proximity to the wedge leading edge and the generated flow field was found to be highly unsteady. Author

A93-24855#
MULTIGRID TECHNIQUES FOR HYPERSONIC VISCOUS FLOWS

F. GRASSO and M. MARINI (Roma I, Univ., Rome, Italy) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by Dassault Aviation and ASI refs (AIAA PAPER 93-0771) Copyright

A multigrid technique for viscous hypersonic flows is presented which is based on the full approximation storage full multigrid method and a 'V-cycle' strategy with direction dependent grid transfer operators. The full Navier-Stokes equations are solved using a finite volume approach with cell centered formulation based on an adaptive dissipation scheme. Time integration is performed by a multistage explicit Runge Kutta algorithm. The technique was applied to compute laminar hypersonic flows over plates, compression ramps, and complex shock wave-boundary layer interactions. Results indicate that the complexity of the flow deteriorates the efficiency of the multigrid algorithm. O.G.

A93-24858*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

WAVERIDER DESIGN FOR GENERALIZED SHOCK GEOMETRIES

K. D. JONES, F. C. DOUGHERTY, A. R. SEEBASS (Colorado Univ., Boulder), and H. SOBIECZKY (DLR, Goettingen, Germany) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by DLR and Univ. of Colorado refs (Contract NAG1-1295) (AIAA PAPER 93-0774) Copyright

A new design method for waverider configurations with generalized shock geometries is presented. A cross-stream Euler marching procedure is used to define the post-shock flow field, and an arbitrary 3D shock shape is specified as an input. This approach makes it possible to use nonaxisymmetric shock topologies with nonconstant shock strengths. The problem is reformulated in the proper curvilinear coordinate system to suppress its fundamental ill-posedness. O.G.

A93-24861*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL SIMULATION OF CROSSING/TURBULENT BOUNDARY LAYER INTERACTION AT MACH 8.3
COMPARISON OF ZERO AND TWO-EQUATION TURBULENCE MODELS

N. NARAYANSWAMI (Rutgers Univ., Piscataway, NJ), C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA), and D. D. KNIGHT (Rutgers Univ., Piscataway, NJ) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract AF-AFOSR-86-0266) (AIAA PAPER 93-0779) Copyright

A 3D hypersonic crossing shock wave/turbulent boundary layer interaction is examined numerically. The test geometry consists of a pair of opposing sharp fins of angle $\alpha = 15$ deg mounted on a flat plate. The freestream Mach number is 8.28. Two theoretical models are evaluated. The full 3D Reynolds-averaged Navier-Stokes equations are solved using the Baldwin-Lomax algebraic turbulent eddy viscosity model and the Rodi turbulence model. Computed results for both cases show good agreement with experiment for flat plate surface pressure and for pitot pressure and yaw angle profiles in the flowfield. General agreement is obtained for surface flow direction. Fair to poor agreement is obtained for surface heat transfer, indicating a need for more accurate turbulence models. The overall flowfield structure is similar to that observed in previous crossing shock interaction studies. Author

A93-24862*# National Aeronautics and Space Administration, Washington, DC.

INTERACTION STRENGTH AND MODEL GEOMETRY EFFECTS ON THE STRUCTURE OF CROSSING-SHOCK WAVE/TURBULENT BOUNDARY-LAYER INTERACTIONS

T. J. GARRISON and G. S. SETTLES (Pennsylvania State Univ., University Park) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract AF-AFOSR-89-0315; NGT-50952) (AIAA PAPER 93-0780) Copyright

The flowfield structure of a range of symmetric crossing-shock wave/turbulent boundary-layer interactions of varying strength is presented. The test geometry, consisting of a symmetric pair of opposing sharp fins at angle of attack, α , mounted to a flat plate, is studied experimentally for a range of α from 7 to 15 degrees at Mach numbers of 3 and 4. Results reveal that the basic flowfield shock structure remains similar in nature over the range of interaction strengths examined, with the only changes being in the scale and location of the various features present. The separated flow regions are classified as being either completely or partially separated, the completely separated case being the one in which the entire incoming boundary layer separates from the plate surface. For the current experiments, all but the weakest of the interactions exhibited complete boundary layer separation. Finally, the effects of model geometry are analyzed by comparing data for shock generators of varying lengths, with the results showing no evidence of upstream influence due to the shock generator trailing edges. Author

A93-24863*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

HYPERSONIC CROSSING SHOCK-WAVE/TURBULENT-BOUNDARY-LAYER INTERACTIONS

M. I. KUSSOY, K. C. HORSTMAN (Elort Inst., Palo Alto, CA), and C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract NCC2-452) (AIAA PAPER 93-0781) Copyright

Experimental data for two three-dimensional intersecting shock-wave/turbulent boundary-layer interaction flows at Mach 8.3 are presented. The test bodies, composed of two sharp fins fastened to a flat plate test bed, were designed to generate flows

with varying degrees of pressure gradient, boundary-layer separation, and turning angle. The data include surface pressure and heat transfer distributions as well as mean flow field surveys both in the undisturbed and interaction regimes. The data are presented in a convenient form to be used to validate existing or future computational models of these hypersonic flows. Author

A93-24864*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

A STUDY OF CFD ALGORITHMS APPLIED TO COMPLETE AIRCRAFT CONFIGURATIONS

BHARAT K. SONI, DAVID H. HUDDLESTON, ABDOLLAH ARABSHAHI, BRUCE VU (NSF, Engineering Research Center for Computational Field Simulation; Mississippi State Univ., Mississippi State), NISHEETH PATEL, JERRY CLARKE, and MONTE COLEMAN (U.S. Army, Ballistic Research Lab., Aberdeen Proving Ground, MD) Jan. 1993 18 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by USAF, McDonnell Aircraft Co., Teledyne Brown Engineering, and NASA refs (AIAA PAPER 93-0784) Copyright

Research aimed at increasing the efficiency and productivity of an overall CFD simulation process, from geometry definition to post processing of results as applied to complete aircraft configurations is reviewed. The progress was achieved through enhancements in geometry processing, surface grid generation, grid refinement, grid adaptation, and domain decomposition strategies. Algorithms for surface grid redistribution, automatic remapping, elliptic refinement and grid adaptation utilize the direct and inverse nonuniform rational B spline based surface representation. O.G.

A93-24865*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A CONCURRENT HYBRID NAVIER-STOKES/EULER APPROACH TO FLUID DYNAMIC COMPUTATIONS

DOMINGO A. TAVELLA, M. J. DJOMEHRI, KATHERINE T. KISLITZIN, MATTHEW W. BLAKE, and LARRY L. ERICKSON (NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0789) Copyright

We present a methodology for the numerical simulation of flow fields by the simultaneous application of two distinct approaches to computational aerodynamics. We compute the three dimensional flow field of a missile at moderate angle of attack by dividing the flow field into two regions: a region near the surface where we use a structured grid and a Navier Stokes solver, and a region farther away from the surface where we utilize an unstructured grid and an Euler solver. The two solvers execute as independent UNIX processes either on the same machine or on two machines. The solvers communicate data across their common interfaces within the same machine or over the network. The computations indicate that extensively separated flow fields can be computed without significant distortion by combining viscous and inviscid solvers. Author

A93-24869#

A PHYSICALLY GUIDED ZONAL APPROACH FOR TWO-DIMENSIONAL AEROFOIL FLOWS

X. M. MARGOT (Imperial College of Science, Technology, and Medicine, London, United Kingdom) and J. J. MCGUIRK (Loughborough Univ., United Kingdom) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by Ministry of Defence Procurement Executive refs (AIAA PAPER 93-0790) Copyright

The paper describes a novel approach to the zonal modeling of aerofoil flows in which Euler and Navier-Stokes CFD methods are combined to achieve optimum computational accuracy and economy. A key element in the present zonal method is the use of an initial, coarse mesh, Navier-Stokes solution for the entire problem which is analyzed to identify a zonal interface containing

the strong viscous regions of the flow. An Euler solution is then carried out outside the zonal interface, and is coupled to a fine-mesh Navier-Stokes solution obtained internal to the interface, using fixed normal velocity interface conditions. Illustrative calculations are presented for laminar subsonic flow around a NACA 0012 aerofoil; these demonstrate the success of the method, and indicate CPU savings approaching 50 percent have been achieved. Author

A93-24925*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

VORTEX/SURFACE INTERACTION

G. C. R. BODSTEIN, A. R. GEORGE, and C. Y. HUI (Cornell Univ., Ithaca, NY) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by Cornell Univ. refs (Contract NAS1-19145; NAG1-1396) (AIAA PAPER 93-0863) Copyright

This paper considers the interaction of a vortex generated upstream in a flow field with a downstream aerodynamic surface that possesses a large chord. The flow is assumed to be steady, incompressible, inviscid and irrotational, and the surface to be semiinfinite. The vortex is considered to be a straight vortex filament. To lowest order the problem is modeled using potential theory, where the 3D Laplace's equation for the velocity potential on the surface is solved exactly. The closed-form equation for pressure distribution obtained from this theory is found to have a square root singularity at the leading-edge. It also converges, as x goes to infinity, to the solution of the 2D point-vortex/infinite plane problem. The pressure coefficient presents an anti-symmetric behavior, near the leading-edge and a symmetric behavior as x goes to infinity. Author

A93-24926#

NUMERICAL SIMULATION OF VORTEX GENERATION AND CAPTURE ABOVE AN AIRFOIL

J. F. SLOMSKI and R. M. COLEMAN (U.S. Navy, Naval Surface Warfare Center, Bethesda, MD) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0864)

This research examines some details associated with numerical simulation of vortex capture above an airfoil. The two dimensional, compressible Navier-Stokes equations were solved for flows around an NACA 64-008 airfoil with suction and blowing boundary conditions on the upper surface of the airfoil. A nine zone C-type grid formed the computational domain. Essentially, the numerical solutions show that an external vortex can be captured above the airfoil provided sufficient surface blowing and suction are used. Increases in lift coefficient above the base case (no external vortex) were as high as 87 percent, and the attendant drag coefficient increases in some cases can be surprisingly small. Changes in airfoil pitching moment coefficient caused by the external vortex are small enough that standard methods of trim should be sufficient to maintain aircraft stability. Author

A93-24927#

THREE DIMENSIONAL NEAR FIELD BEHAVIOR OF A TIP VORTEX DEVELOPING ON AN ELLIPTIC FOIL

E. M. POGOZELSKI, A. SHEKARRIZ, J. KATZ (Johns Hopkins Univ., Baltimore, MD), and T. T. HUANG (U.S. Navy, Naval Surface Warfare Center, Bethesda, MD) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by U.S. Navy refs (AIAA PAPER 93-0865) Copyright

The near-field behavior of a tip vortex evolving behind an elliptic wing at an incidence of 10 deg and $Re(c) = 4.64 \times 10^5$ is examined in this paper. Experiments were performed in a towing tank using Particle Displacement Velocimetry. The result demonstrate that the flow in the near field deviates considerably from the classical assumption of axisymmetry, and that locally, the convective terms of the momentum equation can be as high as 30 percent of $V(\theta)^2/r$. The extent of vortex

meandering is found to be about half of the core size, where the core size is about 2 percent of the root chord length of the wing. Maximum tangential velocities measured are comparable to the free stream velocity. Author

A93-24928#

A SIMPLE CRITERION FOR VORTEX BREAKDOWN

E. J. JUMPER, R. C. NELSON, and K. CHEUNG (Notre Dame Univ., IN) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research sponsored by Univ. of Notre Dame refs (Contract F49620-92-J-0105) (AIAA PAPER 93-0866) Copyright

This paper addresses the spiral form of vortex breakdown. A simple model that incorporates the experimentally-observed geometry of spiral breakdown is presented. Results from computations based on this model are examined and conditions necessary for breakdown are extracted. Nondimensionalization of these conditions leads to a single criterion for breakdown. This criterion is applied to a variety of delta-wing configurations and found to reproduce the general trends observed in experiments. Author

A93-24930#

A STUDY OF SINGLE JET IMPINGEMENT GROUND EFFECT LIFT LOSS

XIN ZHANG (City Univ., London, United Kingdom) and DAN N. ING (Logico Systems, Ltd., East Horsley, United Kingdom) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by British Aerospace Defence, Ltd refs (AIAA PAPER 93-0869) Copyright

A study was carried out on single round jet ground effect lift loss. The jet exit Mach number and velocity were 0.71 and 240 m/s respectively. The effects of ground height, baffle plate edge, jet exit turbulent intensity were assessed. Three baffle plate edges were tested and the ground heights varied from $\eta = 0.15$ to 0.8. It was found that flow mechanisms varied significantly with ground heights. A coherent vortex existed between the baffle plate and the ground at the low ground heights, which suppressed and/or delayed separation at the baffle plate edge and induced high lift loss. At the high ground heights, the vortex disappeared and separation at the plate edge played an important part in determining the lift loss. The baffle plate edge was found to account for as much as 14 percent of the ground effect lift loss. The stress model was found to improve the accuracy of the prediction. Author

A93-24931*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A NUMERICAL INVESTIGATION OF A SUBSONIC JET IN A CROSSFLOW

STEPHEN H. CHIU (California Polytechnic State Univ., San Luis Obispo), KARLIN R. ROTH, RICHARD J. MARGASON (NASA, Ames Research Center, Moffett Field, CA), and JIN TSO (California Polytechnic State Univ., San Luis Obispo) Jan. 1993 21 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0870) Copyright

A numerical analysis is presented of the flowfield induced by a single subsonic jet exhausting perpendicularly from a flat plate into a subsonic crossflow. The analysis used available experimental data from a test case where the jet Mach number was 0.78 and the freestream Mach number was 0.13. Time-averaged solutions were obtained using the thin-layer Navier-Stokes equations and two overlapping grids. The effect of turbulence model on the solutions was evaluated using two turbulence models: the zero-equation two-layer Baldwin-Lomax (1978) turbulence model and the one-equation Baldwin-Barth (1990) turbulence model. It was found that, for some conditions, the zero-equation Baldwin-Lomax turbulence model gave better results than the one-equation Baldwin-Barth model or the laminar case. I.S.

A93-24932#

EXPERIMENTAL INVESTIGATION OF ROTOR/LIFTING SURFACE INTERACTIONS

J. G. LEISHMAN (Maryland Univ., College Park) and NAI-PEI BI (Advanced Technologies, Inc., Newport News, VA) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by Mina-Martin Aeronautical Research Fund refs (Contract DAAL03-88-C-0002) (AIAA PAPER 93-0871) Copyright

Experiments were conducted to study the aerodynamic interactions between a rotor and a fixed lifting surface. A low aspect ratio rectangular wing was positioned at different locations in a rotor flow-field to simulate the aerodynamic environment encountered by the wings of tilt-rotors, or by the empennage of helicopters. Steady and unsteady pressure measurements were made on the wing at various chordwise and spanwise stations for various rotor thrusts and advance ratios. Flow visualization was performed using the wide-field shadow-graph method, which helped to identify the locations of the rotor wake relative to the wing. The results have shown that the lifting surface operates in a highly unsteady three-dimensional flow environment, with regions of partial or complete flow separation. In addition, large unsteady loads were induced on the wing due to rotor blade passage effects and/or induced loads due to close passage or impingement of the rotor tip vortices on the wing surface. Author

A93-24933#

A NEW METHOD FOR IMPROVED ROTOR FREE-WAKE CONVERGENCE

G. L. CROUSE, JR. and J. G. LEISHMAN (Maryland Univ., College Park) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract DAAL03-88-C-0002) (AIAA PAPER 93-0872) Copyright

While traditional free-wake methods are potentially the most accurate means of modeling a rotor wake, their use has been hampered by difficulties in their numerical convergence in hover and in low-speed flight. Since experimental flow visualization data has shown evidence of an instability in the tip vortex geometry in hover, it has been conjectured that this lack of convergence results from an inherent physical instability in the rotor wake system. However, more recent evidence suggests that the convergence problems are primarily caused by numerical instabilities associated with the explicit methods used for solution of the governing differential equations. An improved method for calculating rotor free-wake geometries is presented that uses a predictor-corrector scheme for solution of the governing equations. It is shown that this method allows better wake convergence in hover and low-speed flight, yet does not substantially increase computational cost. Author

A93-24934#

VISCOUS FLOW COMPUTATIONS OF FLOW FIELD AROUND AN ADVANCED PROPELLER

T. B. LIM and LAKSHMI N. SANKAR (Georgia Inst. of Technology, Atlanta) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0873) Copyright

An existing inviscid Euler analysis capable of solving the inviscid compressible flow and the aeroelastic response of advanced propeller has been recently modified to handle viscous flow. The results of viscous flow calculations for the advanced SR7L configuration are reported in the present work. The results are in good agreement with experimental data. The calculations obtained are able to capture several important flow features such as the formation and roll-up of blade tip vortices and secondary radial flow over the blade surface. Author

A93-24935#

INVESTIGATION OF METHODS FOR MODELING PROPELLER-INDUCED FLOW FIELDS

G. J. SCHIPHOLT, N. VOOGT, and J. VAN HENGST (Fokker

Aircraft, Schiphol, Netherlands) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0874) Copyright

A short review is given of computational methods developed in the Netherlands for analysis of propeller/airframe interference. Recent improvements in actuator disk models for propellers operating at higher angles of attack in non-uniform flowfields, are discussed. Euler computations incorporating those models are validated against experiments specifically aimed at gaining insight into aspects of angle of attack effects on propeller slipstreams.

Author

A93-24936#

A FULLY IMPLICIT NAVIER-STOKES ALGORITHM USING AN UNSTRUCTURED GRID AND FLUX DIFFERENCE SPLITTING
DOYLE D. KNIGHT (Rutgers Univ., Piscataway, NJ) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(Contract DAAL03-91-G-0096)
(AIAA PAPER 93-0875) Copyright

An implicit algorithm is developed for the two-dimensional, compressible, laminar Navier-Stokes equations using an unstructured grid of triangles. A cell-centered data structure is employed with the flow variables stored at the centroids of the triangles. The algorithm is based on Roe's flux difference split method for the inviscid fluxes, and a discrete representation of the viscous fluxes and heat transfer using Gauss's Theorem. Linear reconstruction of the flow variables to the cell faces, employed for the inviscid terms, provides second order spatial accuracy. Interpolation of the flow variables to the nodes is achieved using a second-order accurate method. Temporal discretization employs Euler, Trapezoidal or 3-Point Backward differencing. The complete, exact Jacobian of the inviscid and viscous terms is derived. The algorithm is applied to the Riemann Shock Tube problem, a supersonic laminar boundary layer on a flat plate, and subsonic viscous flow past an NACA 0012 airfoil. Results are in excellent agreement with theory and previous computations.

Author

A93-24937#

A COMPARISON OF 'NEW' AND 'OLD' FLUX-SPLITTING SCHEMES FOR THE EULER EQUATIONS
LORENZO BERGAMINI and PASQUALE CINNELLA (Mississippi State Univ., Mississippi State) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by NSF and Politecnico di Bari refs
(AIAA PAPER 93-0876) Copyright

Three different algorithms for the discretization of the inviscid fluxes for the Euler equations are implemented and compared in terms of accuracy, efficiency, and robustness in conjunction with both inviscid and viscous calculations. The first two are the well established flux-splitting techniques developed by Roe and Van Leer for perfect gases, and the third one is a newly proposed algorithm derived by Liou and Steffen. The techniques investigated are presented in a form that is immediately applicable to the study of three-dimensional flows in thermo-chemical non-equilibrium and remains valid when moving and deforming grids are utilized. Numerical results are presented for several test cases in one and two space dimensions, including both unsteady and steady simulations.

Author

A93-24939#

JACOBIAN UPDATE STRATEGIES FOR QUADRATIC AND NEAR-QUADRATIC CONVERGENCE OF NEWTON AND NEWTON-LIKE IMPLICIT SCHEMES
DANIEL B. KIM and PAUL D. ORKWIS (Cincinnati Univ., OH) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by USAF refs
(AIAA PAPER 93-0878) Copyright

Several Jacobian matrix simplification ideas for Newton and Newton-like implicit Navier-Stokes equation solvers were evaluated. The Jacobian matrix simplifications involve updating only selected

parts of the matrix with the most recently computed variables, freezing the entire Jacobian matrix after a specific number of iterations, and combining the two approaches. Numerical experiments were performed with these methods by computing supersonic flat plate and flat plate/wedge test cases. It was found that the approximate methods can give quadratic or better convergence rates if properly implemented.

Author

A93-24940#

APPLICATION OF HIGH-ORDER ACCURATE ESSENTIALLY NONOSCILLATORY SCHEMES TO TWO-DIMENSIONAL COMPRESSIBLE VISCOUS FLOWS

XIAOLIN ZHONG (California Univ., Los Angeles) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(Contract F49620-92-J-0090)
(AIAA PAPER 93-0879) Copyright

The complexity of hypersonic flow requires efficient and accurate numerical methods for flow-field prediction. Since the current numerical methods for hypersonic flow computations are usually only second order accurate, we apply the essentially nonoscillatory (ENO) schemes, which are uniformly high order accurate to two-dimensional compressible viscous flow, with solid boundaries using body-fitted structured grids. Implicit methods are used to solve the Navier-Stokes equations by using the ENO schemes for the test cases of steady high-Reynolds-number viscous flows, which include supersonic boundary layer, shock/boundary-layer interaction flow, and type IV hypersonic shock-wave interference heating problem. Results of the third order accurate ENO scheme for solving the Navier-Stokes equations have been obtained for the test cases. These results show that the 2D ENO schemes are able to compute viscous flows with high resolution.

Author

A93-24943#

A NUMERICAL STUDY OF UNSTEADY SUPERSONIC COMPRESSION RAMP FLOWS

S. O. PARK, Y. M. CHUNG, and H. J. SUNG (Korea Advanced Inst. of Science and Technology, Taejeon, Republic of Korea) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0883) Copyright

As a fundamental problem of unsteady supersonic flow, the inviscid supersonic flow past a moving compression ramp of which the wedge angle varies linearly with time up to a given angle is studied numerically. The Runge-Kutta time stepping scheme with moving grid has been employed to integrate the Euler equations. It is found that the flow can be regarded as steady when the reduced angular velocity is smaller than 0.01. When the reduced angular velocity is greater than 0.1, distinct unsteady behaviors are noticed. Formation of oblique shock wave and the transient pressure change during the ramp motion are discussed.

Author

A93-24944#

COMPUTATION OF INVISCID FLOWFIELD AROUND 3-D AEROSPACE VEHICLES AND COMPARISON WITH EXPERIMENTAL AND FLIGHT DATA

MICHAEL Y. AN, K. C. WANG, and LUEN T. TAM (Lockheed Engineering & Sciences Co., Houston, TX) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0885)

A 3-dimensional, shock capturing, inviscid CFD code called IEC3D has been developed for supersonic and hypersonic flow computations around 3-dimensional aerospace vehicles for a wide range of flight conditions and angles-of-attack. This code utilizes an upwind-biased, finite-volume, high-order Total Variation Diminishing (TVD) scheme based on either Van Leer's Monotone Upstream-centered Scheme for Conservation Laws (MUSCL) type flux-vector splitting or Roe's characteristic-based flux-difference splitting. It also incorporates the Lower-Upper Symmetric Gauss-Seidel (LU-SGS) implicit solver to very efficiently solve the Euler equations. Computed perfect gas solutions of the Space

Shuttle Orbiter are compared with available wind tunnel data. In addition, both perfect gas and equilibrium air solutions of the nose region of the Space Shuttle Orbiter are computed and compared with the Shuttle Entry Air Data System (SEADS) flight data. These comparisons show that the IEC3D code is capable of predicting reasonably-accurate inviscid flowfields around 3-dimensional aerospace vehicles at both wind tunnel and flight conditions.

Author

A93-24945*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

INVESTIGATION OF THREE-DIMENSIONAL SEPARATION AT WING/BODY JUNCTIONS IN SUPERSONIC FLOWS USING TVD MACCORMACK'S SCHEME

B. LAKSHMANAN (Old Dominion Univ., Norfolk; NASA, Langley Research Center, Hampton, VA) and S. N. TIWARI (Old Dominion Univ., Norfolk, VA) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract NAG1-530)

(AIAA PAPER 93-0884) Copyright

A Total Variation Diminishing (TVD) MacCormack scheme is used to study the three-dimensional separation at wing/body junctions in supersonic flows. The new scheme is robust, resolves discontinuities well without any numerical oscillations present in the flow field. Moreover, this new scheme does not contain any problem dependent parameters to be adjusted and many production codes employing MacCormack algorithm can be easily updated to good effect. Numerical simulation carried out in laminar supersonic junction flows using the new scheme yields improved prediction for the separation location and the axial velocity profiles in the separated flow region.

Author

A93-24946#

NUMERICAL SIMULATION OF SUPERSONIC FLOW AROUND SPACE PLANE FOR AIRFRAME-ENGINE INTEGRATION

SHINICHI KURODA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0886) Copyright

The flow around an airframe-engine integration model is numerically simulated. Because of the geometrical complexity, the overlaid composite grid approach based on the Fortified Solution Algorithm (FSA) concept is used for the discretization strategy. The composite grid consists of four component grids. The primary grid is constructed with respect to the airframe, and the subsidiary grids are generated about the nacelle, duct and boundary-layer diverter. The minor grids are used to resolve the features of the engine geometry and are overlaid on the main grid. The inviscid flow field is solved for this configuration at a Mach number of 2.75 and zero degrees angle of attack. Although the overall flow features are successfully simulated by this preliminary computation, Navier-Stokes simulations are left as a future work. A preliminary computation for the viscous flow field around the boundary-layer diverter is included.

Author

A93-24947#

NUMERICAL INVESTIGATION OF SUPERSONIC FLOWS AROUND A SPIKED BLUNT-BODY

MASAFUMI YAMAUCHI (Tokyo Noko Univ., Koganei, Japan), KOZO FUJII, YOSHIKI TAMURA (Inst. of Space and Astronautical Science, Sagami, Japan), and FUMIO HIGASHINO (Tokyo Noko Univ., Koganei, Japan) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0887) Copyright

In supersonic flows, a spike attached on the nose reduces the drag of the blunt body. In the present paper, supersonic flows around a spiked blunt body are numerically simulated to examine the effects of the spike length, Mach numbers and angles of attack. Three-dimensional 'thin-layer' compressible Navier-Stokes equations are solved using a high-resolution upwind scheme with LU-ADI time integration. The computed results show that the drag

of the spiked blunt body is remarkably influenced by the spike length. When the spike is long, the pressure level on the body surface is very low and the drag becomes small. Though the flow field at M freestream Mach number = 2.01 looks remarkably different from that at M freestream Mach number = 4.15 or 6.80, all the flow fields are characterized by the conical shock wave from the tip of the spike, the bow shock wave of the blunt body and the separated region in front of the blunt body. Scales of the separated region are not much influenced by the freestream Mach number.

Author

A93-24950#

TGV TUNNEL ENTRY SIMULATIONS USING A FINITE ELEMENT CODE WITH AUTOMATIC REMESHING

ERIC MESTREAU (Engineering Systems International, Rungis, France; George Washington Univ., Washington), RAINALD LOEHNER (George Washington Univ., Washington), and SAMIR AITA (Engineering Systems International, Rungis, France) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by GEC Alstom refs

(AIAA PAPER 93-0890) Copyright

Simulations of the unsteady aerodynamics of the French TGV trains during tunnel entry are presented. These calculations have been performed using a novel edge-based finite element code that employs automatic remeshing to account for moving bodies. The comparison with experimental results shows that this tool can be used to predict the pressure waves generated inside the tunnels, the main source of passenger discomfort. Several numerical issues are also addressed in order to enable such simulations to be used during the design stage for this critical problem of high speed trains.

Author

A93-24951*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPUTING 3-D STEADY SUPERSONIC FLOW VIA A NEW LAGRANGIAN APPROACH

C. Y. LOH and M.-S. LIOU (NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0891)

The new Lagrangian method introduced by Loh and Hui (1990) is extended for 3-D steady supersonic flow computation. Details of the conservation form, the implementation of the local Riemann solver, and the Godunov and the high resolution TVD schemes are presented. The new approach is robust yet accurate, capable of handling complicated geometry and reactions between discontinuous waves. It keeps all the advantages claimed in the 2-D method of Loh and Hui, e.g., crisp resolution for a slip surface (contact discontinuity) and automatic grid generation along the stream.

Author

A93-24953#

HYPersonic INVISCID AND VISCOUS FLOW COMPUTATIONS WITH A NEW OPTIMIZED THERMODYNAMIC EQUILIBRIUM MODEL

M. GAZAIX (ONERA, Chatillon, France) Jan. 1993 21 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by DRET refs (AIAA PAPER 93-0893) Copyright

This paper treats the development of an accurate, numerically efficient thermodynamic model for air in chemical equilibrium. We first review different thermodynamic models of air chemistry, and give some indications about their relative merits. A general study of the qualities required by a numerical modelling of chemical equilibrium in the context of hypersonic flow computation is given. We discuss next the problem of optimal approximation of two-dimensional thermodynamic surfaces and explain why local piecewise approximation is superior to global approximation (by polynomials or rational fractions). We describe the construction of the new numerical approximation that has been developed using bicubic spline or bicubic Hermite piecewise polynomials, and its implementation in FLU3M, a 3D Euler/Navier-Stokes multidomain

code based on an implicit upwind scheme. The paper ends with examples of inviscid and viscous equilibrium air flow computations. Author

A93-24954* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN UPWIND, KINETIC FLUX-VECTOR SPLITTING METHOD FOR FLOWS IN CHEMICAL AND THERMAL NON-EQUILIBRIUM

W. M. EPPARD and B. GROSSMAN (Virginia Polytechnic Inst. and State Univ., Blacksburg) Jan. 1993 14 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(Contract NAG1-776)
(AIAA PAPER 93-0894) Copyright

We have developed new upwind kinetic difference schemes for flows with non-equilibrium thermodynamics and chemistry. These schemes are derived from the Boltzmann equation with the resulting Euler schemes developed as moments of the discretized Boltzmann scheme with a locally Maxwellian velocity distribution. Splitting the velocity distribution at the Boltzmann level is seen to result in a flux-split Euler scheme and is called Kinetic Flux Vector Splitting (KFVS). Extensions to flows with finite-rate chemistry and vibrational relaxation is accomplished utilizing nonequilibrium kinetic theory. Computational examples are presented comparing KFVS with the schemes of Van Leer and Roe for a quasi-one-dimensional flow through a supersonic diffuser, inviscid flow through two-dimensional inlet, and viscous flow over a cone at zero angle-of-attack. Calculations are also shown for the transonic flow over a bump in a channel and the transonic flow over an NACA 0012 airfoil. The results show that even though the KFVS scheme is a Riemann solver at the kinetic level, its behavior at the Euler level is more similar to the existing flux-vector splitting algorithms than to the flux-difference splitting scheme of Roe. Author

A93-24956#
ON THE BREAKDOWN OF A HYPERSONIC LAMINAR BOUNDARY LAYER

KENNETH F. STETSON and ROGER L. KIMMEL (USAF, Wright Lab., Wright-Patterson AFB, OH) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0896)

Results are presented from boundary-layer stability experiments of Stetson and Kimmel (1992), showing that these data, supported by data obtained by Demetriades (1975, 1977) and Pate (1978) are inconsistent with the Fisher-Weinstein (1972) transition onset model. The experimental stability-related data do not provide any support for the Fisher-Weinstein claim that transition onset is well upstream of the location where transition is detected at the surface or that the onset of transition at the surface coincides with the location where the disturbances have spread to the surface. The data show that the onset of spreading of boundary-layer disturbances was closely related to the onset of transition at the surface. I.S.

A93-24957#
A NEW MODEL FOR SUPER/HYPERSONIC TURBULENT BOUNDARY LAYERS

OTTO ZEMAN (Stanford Univ., CA) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0897) Copyright

In this paper new compressible models and theories that lead to their development are reviewed with the focus on the compressibility effects pertaining to turbulent boundary layers (TBL's) in quasi-equilibrium. The primary purpose of the paper is to report on a new Reynolds stress closure model (RSC) developed for super/hypersonic TBL's and comparison of model results with experiments in zero pressure gradient TBL's up to freestream Mach number $Me = 10.3$. Both insulated and cooled wall TBL's are considered. Finally, the physics and the importance of the inclusion

of the compressible terms in the modeling equations are discussed. The set of model equations applicable to a general turbulent compressible flow is presented. Author

A93-24972#
TIME-RESOLVED SURFACE HEAT FLUX MEASUREMENTS IN THE WING/BODY JUNCTION VORTEX

D. J. LEWIS, R. L. SIMPSON, and T. E. DILLER (Virginia Polytechnic Inst. and State Univ., Blacksburg) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(Contract AF-AFOSR-91-0310)
(AIAA PAPER 93-0918) Copyright

Time and spatially resolved heat flux measurements have been made on the endwall surface in the turbulent, incompressible flow in the nose region of a wing/body junction formed by a wing and a flat plate. Both the wing and the flat plate were heated and held at a constant uniform temperature. Several wing shapes were used to investigate the effects of wing geometry on heat transfer. The wing shapes used were a 3:2 semi-elliptic nose/NACA 0020 tailed body, a tear drop shape, and a NACA 0015. The measurements were made at a nominal temperature difference of 20 degrees C between the free-stream air and the heated surface. The free-stream approach velocity was 32.3 m/s and the Reynolds number based on approach momentum thickness was 3730. The measurements were used to calculate contours of the mean and fluctuating heat transfer. High values of turbulent heat transfer fluctuations were found in the vortex-dominated nose region. Histograms and power spectra of the heat transfer fluctuations are presented. The histograms show high levels of both flatness and skewness in the region of the junction vortex. The power spectra show that the heat transfer fluctuations in this region are dominated by low frequency, large scale unsteadiness. A correlation to account for the effect of high levels of turbulence in the vortex region has also been investigated. Author

A93-24978# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EFFECT OF A ROTATING PROPELLER ON THE SEPARATION ANGLE OF ATTACK

D. R. BOLDMAN, C. IEK, D. P. HWANG (NASA, Lewis Research Center, Cleveland, OH), M. LARKIN, and P. SCHWEIGER (Pratt & Whitney Group, East Hartford, CT) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Previously announced in STAR as N93-16625 refs
(Contract RTOP 505-03-10)
(AIAA PAPER 93-0017) Copyright

The present study represents an extension of an earlier wind tunnel experiment performed with the P&W 17-in. Advanced Ducted Propeller (ADP) Simulator operating at Mach 0.2. In order to study the effects of a rotating propeller on the inlet flow, data were obtained in the UTRC 10- by 15-Foot Large Subsonic Wind Tunnel with the same hardware and instrumentation, but with the propeller removed. These new tests were performed over a range of flow rates which duplicated flow rates in the powered simulator program. The flow through the inlet was provided by a remotely located vacuum source. A comparison of the results of this flow-through study with the previous data from the powered simulator indicated that in the conventional inlet the propeller produced an increase in the separation angle of attack between 4.0 deg at a specific flow of 22.4 lb/sec-sq ft to 2.7 deg at a higher specific flow of 33.8 lb/sec-sq ft. A similar effect on separation angle of attack was obtained by using stationary blockage rather than a propeller. Author

A93-24986#
SUPERCritical WING DESIGN, A THREE DIMENSIONAL HODOGRAPH APPROACH

GABRIEL OYIBO, JOHN J. NUTAKOR, and KYUNG-SOO JANG (Polytechnic Univ., Farmingdale, NY) Jun. 1992 6 p. AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24,

1992 refs

(Contract AF-AFOSR-89-5500)

(AIAA PAPER 92-2657) Copyright

The finite difference method of Garabedian, Korn and Bauer has been extended to a 3D hodograph shock-free wing design method of Oyibo. The preliminary investigation indicates that the new 3D hodograph equation can be conveniently manipulated in a manner that would permit proper adaptation of 2D Garabedian, Korn and Bauer method. The exercise results in a hybrid of numerical and analytical method for designing 3D shock-free wings that fly in the transonic region. It is seen that the process of pushing the shockwave toward the trailing edge and diluting its strength or hiding the shocks/singularities inside the wing can be made to work for 3D wing. The results further show some new, potentially promising 3D shock-free wing shapes. Author

A93-24988#**AERODYNAMIC ANALYSES FOR DESIGN AND EDUCATION**

ILAN KROO (Stanford Univ., CA) Jun. 1992 10 p. AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992 refs

(AIAA PAPER 92-2664) Copyright

The paper describes the use of current computer resources in aerodynamic analyses for providing very rapid solutions for use in preliminary design and education. Three specific programs are described: a program for the analysis and design of airfoils; a multiple, nonplanar lifting surface method; and an integrated analysis/hypertext electronic textbook. I.S.

A93-24990#**EXPERIMENTAL AND NUMERICAL DELTA WING STUDY AT HIGH ANGLES OF ATTACK AND SIDESLIP**

MICHAEL PAPADAKIS, DAVID L. PHILLIS, and XIAOXIAN LIU (Wichita State Univ., KS) Jun. 1992 18 p. AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992 refs

(AIAA PAPER 92-2713) Copyright

An experimental study has been conducted to investigate the flowfield of a delta wing at high angles of attack and sideslip. In addition, preliminary computations of such flows using the Navier-Stokes equations have been performed. Experiments were conducted in the 7 x 10 ft subsonic wind tunnel at Wichita State University on a 70 degree sweep delta wing with sharp leading edges. Flow visualization, pressure, force and moment data for angles of attack ranging from 0 to 40 degrees and sideslip angles ranging from 0 to 45 degrees are reported in this paper. Computational results obtained for selected experimental conditions are presented and compared with the experimental results. Author

A93-25060**INTRODUCTION OF SMALL VELOCITY AND PRESSURE VARIATION INTO A STATIONARY COMPRESSIBLE FLUID**

TON TRAN-CONG (Defence Science and Technology Organisation, Aeronautical Research Lab., Fishermens Bend, Australia) Archive of Applied Mechanics (ISSN 0939-1533) vol. 62, no. 4 June 1992 p. 266-276. refs

Copyright

The aerodynamic time-dependent Coulomb and Biot-Savart laws are formulated with inherent transmission retardation, by generalizing the theory of Baskin et al. (1973) for the isentropic propagation of small vortex disturbances, so as to include the propagation of small disturbances caused by a distributed system of both the vortices and the variation in specific entropy of a thermodynamically simple compressible fluid. The results suggest the possibility of using a focused laser spot to simulate the effect of a source in a compressible fluid. A time-dependent 3D formula for lifts caused by small disturbances is developed which is in agreement with Blasius's formula for 2D time-independent inviscid flows. I.S.

A93-25348**EXPERIMENTAL STUDY OF THREE-DIMENSIONAL SEPARATION ON A LARGE-SIZE MODEL [ETUDE EXPERIMENTALE DU DECOLLEMENT TRIDIMENSIONNEL SUR UNE MAQUETTE DE GRANDES DIMENSIONS]**

D. BARBERIS (ONERA, Chatillon, France) ONERA, TP no. 1992-174 1992 34 p. In French. refs

(ONERA, TP NO. 1992-174)

Three-dimensional separation was studied for a flow developing on a large-size model consisting of a half-ellipsoid of revolution continued by a circular cylinder and terminated by a flat bottom inclined at an angle of 45 deg with respect to the cylinder axis. The flow developing around the model, in particular the boundary layer and the vortex structure, was investigated using a laser velocimeter and directional pressure probes. It was observed how a boundary layer develops into a vortex sheet and then into a vortex ordered by the growth of shear along the boundary-layer thickness. This shear augmentation is accompanied by an increase in the angle between the vector defined by the velocity gradient components and the shear stress vector projected in a plane parallel to the surface of the obstacle. L.M.

A93-25360**AN EXAMINATION OF VORTEX CONVECTION EFFECTS DURING BLADE-VORTEX INTERACTION**

M. B. HORNER, E. SALIVEROS, and R. A. MCD. GALBRAITH (Glasgow Univ., United Kingdom) Aeronautical Journal (ISSN 0001-9240) vol. 96, no. 960 Dec. 1992 p. 373-379. Research supported by Ministry of Defence and Royal Aerospace Establishment refs

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The experimental results of a parallel Blade-Vortex Interaction (BVI) study are presented. The quality of all pressure data reflects improvements in the Glasgow University BVI facility and in the method of reducing and presenting data. Pressure histories clearly track the passage of a vortex-associated disturbance across the aerofoil. Tracking this disturbance permits an examination of vortex convection velocities, and also allows for a correlation between vortex trailing edge passage and force and moment perturbations. Author

A93-25510#**PRESSURE MEASUREMENTS ON A PITCHING AIRFOIL IN A WATER CHANNEL**

RAND N. CONGER and B. R. RAMAPRIAN (Washington State Univ., Pullman) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(Contract AF-AFOSR-90-0131; F49620-92-J-0146)

(AIAA PAPER 93-0184) Copyright

Measurements of unsteady pressures over a symmetric NACA 0015 airfoil pitching at constant angular velocity are reported. The tests were performed in an open-surface water channel specially constructed for this purpose. The design of the apparatus allowed the pressure measurements to be made to a very high degree of spatial and temporal resolution. Reynolds numbers in the range of 5.2×10^4 to 2.2×10^5 were studied. While the results qualitatively agreed with earlier studies performed at similar Reynolds numbers, the magnitudes of pressure and aerodynamic forces measured were observed to be much larger than those in earlier pitch-up studies. They were found, in fact, to be closer to those obtained in some recent high-Reynolds number experiments. This interesting behavior, which was suspected to be caused by the relatively high free-stream turbulence level in the water channel, was explored in some detail. In addition, several issues such as the quasi-steady and dynamic effects of the pitching process as well as the influence of initial conditions are discussed. Author

A93-25511#**ARTIFICIAL VISCOSITY MODELS FOR THE NAVIER-STOKES EQUATIONS AND THEIR EFFECT IN DRAG PREDICTION**

SURYAKUMAR REDDY and MICHAEL PAPADAKIS (Wichita State Univ., KS) Jan. 1993 19 p. AIAA, Aerospace Sciences

Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0193) Copyright

Artificial dissipation is often needed in finite difference schemes which use higher order differencing. Some of the most popular dissipation models include Jameson's nonlinear artificial dissipation model, as well as models which are based on total variation diminishing (TVD) principles. The use of these models in conjunction with the Euler equations has been thoroughly investigated. Many researchers have also used these artificial dissipation models in Navier-Stokes computations, but few have reported on the effects of artificial viscosity in the boundary layer. It is the purpose of the present work to examine in detail the influence of artificial dissipation on the natural dissipation for both laminar and turbulent flows. The results indicate that the effects of adding numerical dissipation to the boundary layer degrades the solution in this region, and suggest that artificial dissipation should be limited to the inviscid region of the flow. Author

A93-25512* # National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PROGRESS IN HIGH-LIFT AERODYNAMIC CALCULATIONS

STUART E. ROGERS (NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0194) Copyright

The current work presents progress in the effort to numerically simulate the flow over high-lift aerodynamic components, namely, multi-element airfoils and wings in either a take-off or a landing configuration. The computational approach utilizes an incompressible flow solver and an overlaid chimera grid approach. A detailed grid resolution study is presented for flow over a three-element airfoil. Two turbulence models, a one-equation Baldwin-Barth model and a two equation k- ω model are compared. Excellent agreement with experiment is obtained for the lift coefficient at all angles of attack, including the prediction of maximum lift when using the two-equation model. Results for two other flap riggings are shown. Three-dimensional results are presented for a wing with a square wing-tip as a validation case. Grid generation and topology is discussed for computing the flow over a T-39 Sabreliner wing with flap deployed and the initial calculations for this geometry are presented. Author

A93-25517* # National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

BOUNDARY-LAYER TRANSITION EXTENT MEASUREMENTS ON A CONE AND FLAT PLATE AT MACH 3.5

FANG-JENQ CHEN (NASA, Langley Research Center, Hampton, VA) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0342) Copyright

Wide excursions of the boundary-layer transition region are expected to occur on the X-30 National Aerospace Plane (NASP) due to the high Mach number, high temperature, and low density environment experienced during flight. Undesirable features of the transition region, such as the peak heat transfer rate, make it important to understand transition region physics. The current study investigates transition extent in 2D and axisymmetric boundary-layer flows. Surface-pitot and recovery temperature data obtained on a cone and flat plate at Mach 3.5 in the Supersonic Low-Disturbance Pilot Tunnel at NASA Langley are presented. Results show the effects of the unit Reynolds number, freestream disturbances, and nose/leading-edge bluntness on the extent of transition. Author

A93-25520* #

HYPersonic WAVERIDERS - WHERE DO WE STAND?

JOHN D. ANDERSON, JR. and MARK J. LEWIS (Maryland Univ., College Park) Jan. 1993 14 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0399) Copyright

A development history and current status evaluation are presented for 'waverider' hypersonic vehicle configurations, which have an attached shock wave all along their leading edge; this preserves the pressure differential between upper and lower

surfaces of the lifting body. Three phases of development are apparent: gestation, from 1959 to 1986; viscous optimization, from 1986 to 1992; and vehicle development, after 1992. Attention is given to the effects of chemically reacting flow, viscous interactions, aerothermodynamics, low-density effects, CFD waverider flowfields, propulsion integration, stability/control, and waveriding missiles.

O.C.

A93-25528* #

STRUCTURE OF VORTEX BREAKDOWN ON A PITCHING DELTA WING

MIGUEL R. VISBAL (USAF, Wright Lab., Wright-Patterson AFB, OH) Jan. 1993 22 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0434)

Computational results are presented for transient vortex breakdown above a delta wing subject to a pitch-and-hold maneuver to high angle of attack. The flows are simulated by solving the full 3D Navier-Stokes equations on a moving grid using the implicit Beam-Warming algorithm. The pressure gradient along the vortex axis is found to play a dominant role in the initiation of breakdown. A description of the 3D instantaneous structure of the flow field is provided for the first time using critical-point theory. The reversed-flow region in the vortex core is associated with pairs of opposite spiral/saddle critical points. At its onset, the vortex breakdown is fairly axisymmetric, however, as it proceeds upstream and a stronger transition takes place along the axis, asymmetric effects become important and result in the formation of a bubble-type breakdown. This bubble structure is open and contains within itself a pair of stagnation points which are diametrically opposed and which rotate in the same sense as the base flow. These critical points suggest the existence of azimuthal disturbances, and their rotation might be linked with the coherent oscillations observed in vortex breakdown. Author

A93-25529* #

OSCILLATORY BLOWING, A TOOL TO DELAY BOUNDARY LAYER SEPARATION

A. SEIFERT, T. BACHAR, I. WYGNANSKI (Tel Aviv Univ., Israel), D. KOSS, and M. SHEPSHELOVICH (Israel Aircraft Industries, Ltd., TASHAN Engineering Center, Tel Aviv) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by Ministry of Defense of Israel refs (AIAA PAPER 93-0440) Copyright

The effects of oscillatory blowing as means of delaying separation are discussed. Experiments were carried out on a hollow, flapped NACA 0015 airfoil equipped with a 2D slot over the hinge of the flap. The flap extended over 25 percent of the chord and was deflected at angles as high as 40 deg. The steady blowing momentum coefficients could be varied independently of the amplitudes and frequencies of the superimposed oscillations. The modulated blowing was a major factor in improving the performance of the airfoil at much lower energy inputs that was hitherto known. Optimum benefits in performance were obtained at reduced frequencies, based on the flap chord, of an order of unity. Significant increase in lift as well as cancellation of form drag were observed. The increase in Reynolds number did not have an adverse effect on the data. Author

A93-25536* # National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPUTATIONAL ANALYSIS OF METHODS FOR REDUCTION OF INDUCED DRAG

J. M. JANUS, ANIMESH CHATTERJEE, and CHRIS CAVE (NSF, Engineering Research Center for Computational Field Simulation; Mississippi State Univ., Mississippi State) Jan. 1993 17 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract NAG1-1271)

(AIAA PAPER 93-0524) Copyright

The purpose of this effort was to perform a computational flow analysis of a design concept centered around induced drag

reduction and tip-vortex energy recovery. The flow model solves the unsteady three-dimensional Euler equations, discretized as a finite-volume method, utilizing a high-resolution approximate Riemann solver for cell interface flux definitions. The numerical scheme is an approximately-factored block LU implicit Newton iterative-refinement method. Multiblock domain decomposition is used to partition the field into an ordered arrangement of blocks. Three configurations are analyzed: a baseline fuselage-wing, a fuselage-wing-nacelle, and a fuselage-wing-nacelle-propfan. Aerodynamic force coefficients, propfan performance coefficients, and flowfield maps are used to qualitatively assess design efficacy. Where appropriate, comparisons are made with available experimental data. Author

A93-25546* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

RECENT DEVELOPMENTS IN HIGH ORDER K-EXACT RECONSTRUCTION ON UNSTRUCTURED MESHES

TIMOTHY J. BARTH (NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0668) Copyright

This paper presents recent improvements in high-order K-exact reconstruction on unstructured meshes. The new reconstruction procedures are incorporated into a basic upwind finite-volume scheme suitable for solving scalar advection-diffusion equations as well as the Euler and Navier-Stokes equations. Numerical calculations are performed comparing the present method with lower order accurate reconstruction procedures (piecewise constant and piecewise linear) and various competing technologies such as the fluctuation splitting method of Roe (1987) and Deconinck et al. (1992) and a system-variant of the streamline diffusion Petrov-Galerkin method developed by Hansbo (1991) and Hansbo and Johnson (1991). Five test problems are used in the numerical comparisons: scalar circular advection, transonic and supersonic Euler flow, laminar boundary-layer flow, and general compressible Navier-Stokes flow. Author

A93-25550#

CORRELATION OF INTERACTION SWEEPBACK EFFECTS ON UNSTEADY SHOCK-INDUCED TURBULENT SEPARATION

J. C. GONSALEZ and D. S. DOLLING (Texas Univ., Austin) Jan. 1993 20 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0776) Copyright

An experimental investigation is made of the effects of wing sweepback angle on the separation shock dynamics of turbulent-interaction flow generated by blunt fins with hemicylindrical leading edges. A comparison is made with similar data from interactions generated by sharp fins and swept compression ramps under equivalent flow conditions. The data support a simple model which predicts that the maximum rms of the pressure fluctuations near separation is equal to half the separation shock wave length. Shock zero-crossing frequencies for all geometries correlate with intermittent region length. O.C.

A93-25553* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NONREFLECTING BOUNDARY CONDITIONS FOR LINEARIZED UNSTEADY AERODYNAMIC CALCULATIONS

KENNETH C. HALL, CHRISTOPHER B. LORENCE, and WILLIAM S. CLARK (Duke Univ., Durham, NC) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by NSF and GE Aircraft Engines refs

(Contract NAG3-1192)

(AIAA PAPER 93-0882) Copyright

The present method for the implementation of nonreflecting boundary conditions in 2D and 3D linearized unsteady flow computations is applied to cases of unsteady flows in turbomachine blade rows. The eigenmodes of a discrete representation of the governing equations are computed and used to construct nonreflecting boundary conditions. In 3D, a mixed numerical method

is used; in 2D, the discrete representation of the governing equations is obtained from the discretized equations used by the flow solver itself. Wavenumbers and radial mode shapes are computed. O.C.

A93-26176

THE EFFECT OF REYNOLDS NUMBER ON VORTEX ASYMMETRY ABOUT SLENDER BODIES

J. E. BERNHARDT and D. R. WILLIAMS (Illinois Inst. of Technology, Chicago) Physics of Fluids A (ISSN 0899-8213) vol. 5, no. 2 Feb. 1993 p. 291-293. refs

(Contract F49620-86-C-033)

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The effect of Reynolds number on asymmetric vortex systems was investigated, considering a slender body placed at 55 deg angle of attack in a closed return wind tunnel, where a flow speed ranged from $U = 1.2$ to 42.2 m/sec, and the freestream turbulence level was no greater than 0.1 percent. The Reynolds number Re was varied from 2300 to 80,100. The forebody model consisted of a 15-deg included angle cone mounted on a cylinder. The flowfield near the model tip was modified using suction to remove fluid from the boundary layer. Results showed that the behavior of the vortex system depended strongly on Reynolds number, explaining discrepancies observed by different investigators. I.S.

A93-26183

INDUCED MACH WAVE-FLAME INTERACTIONS IN LAMINAR SUPERSONIC FUEL JETS

F. Q. HU, T. L. JACKSON, D. G. LASSEIGNE, and C. E. GROSCH (Old Dominion Univ., Norfolk, VA) Physics of Fluids A (ISSN 0899-8213) vol. 5, no. 2 Feb. 1993 p. 422-427. Research supported by Old Dominion Univ. refs

(Contract AF-AFOSR-91-0180; NSF DMS-90-07642; AF-AFOSR-91-0250)

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A model problem is proposed to investigate the steady response of a reacting, compressible laminar jet to Mach waves generated by wavy walls in a channel of finite width. The model consists of a two-dimensional jet of fuel emerging into a stream of oxidizer which are allowed to mix and react in the presence of the Mach waves. The governing equations are taken to be the steady parabolized Navier-Stokes equations which are solved numerically. The kinetics is assumed to be a one-step, irreversible reaction of the Arrhenius type. Two important questions on the Mach wave-flame interactions are discussed: (1) how is the flame structure altered by the presence of the Mach waves, and (2) can the presence of the Mach waves change the efficiency of the combustion processes? Author

A93-26880

EUROFAR ROTOR AERODYNAMIC TESTS

FREDERIC BEROUL, PASCAL BASSEZ (Eurocopter France, Marignane), and PATRICK GARDAREIN (ONERA, Chatillon, France) ONERA, TP no. 1992-173 1992 10 p. Research sponsored by DRET and Direction Generale de l'Aviation Civile refs

(ONERA, TP NO. 1992-173)

The test program conducted for the aerodynamic characterization of the European Future Advanced Rotorcraft, or 'Eurofar' tilt-rotor VTOL aircraft's four-bladed rotors is discussed. The tests conditions were vertical-axis hover, horizontal-axis cruise, and the transitioning 'conversion' mode between them. Although the test rotor was only a provisional baseline design, good aerodynamic efficiency performance has been obtained in hover, and even better performance is noted in cruise, relative to the V-22 rotor data that are used as a basis for evaluation. O.C.

A93-26897

ROTOR BLADE UNSTEADY AERODYNAMIC GUST RESPONSE TO INLET GUIDE VANE WAKES

S. R. MANWARING and S. FLEETER (Purdue Univ., West Lafayette, IN) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X) vol. 115, no. 1 Jan. 1993 p. 197-206.

refs

(Contract F49620-88-C-0022)
(ASME PAPER 91-GT-129) Copyright

A series of experiments is performed in an extensively instrumented axial flow research compressor to investigate the fundamental flow physics of wake-generated periodic rotor blade row unsteady aerodynamics at realistic values of the reduced frequency. Unique unsteady data are obtained that describe the fundamental unsteady aerodynamic gust interaction phenomena on the first-stage rotor blades of a research axial flow compressor generated by the wakes from the inlet guide vanes. In these experiments, the effects of steady blade aerodynamic loading and the aerodynamic forcing function, including both the transverse and chordwise gust components, and the amplitude of the gusts, are investigated and quantified. Author

A93-26898

THE AERODYNAMIC LOADS ON AIRCRAFT COMPONENTS IN VIOLENT LONGITUDINAL MANOEUVRES

I. TAPOSU (Inst. of Aviation, Bucharest, Romania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074) vol. 37, no. 4 July-Aug. 1992 p. 441-447. refs

A method compatible with previously defined nonlinear response parameters is presently used to estimate the aerodynamic and inertia loads on an aircraft in the course of violent longitudinal-axis maneuvering. The method presented is valid for maneuvers involving significant variations in altitude and speed, as well as for all flight regimes (sub-, trans-, and supersonic), with errors of the order of 1-3 percent. O.C.

A93-26903

AERODYNAMIC FORCES AND MOMENTS ON A DIHEDRAL SWEEP WING IN A TRANSLATION WITH ATTACK AND SIDE-SLIP ANGLE

M. M. NITA and P. PARVU (Polytechnic Inst., Bucharest, Romania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074) vol. 37, no. 5 Sept.-Oct. 1992 p. 531-538. refs

A short-cut method is presented for determining the aerodynamic forces and moments acting on a nonzero dihedral swept wing during a uniform linear translation at given attack and sideslip angles. General expressions are derived for forces and moments. A strip theory is used to derive general results. L.M.

A93-26905

THE NUMERICAL SIMULATION OF THE HYDRODYNAMIC FIELD FROM THE PUMP IMPELLERS ZONE BY MEANS OF THE FINITE ELEMENT METHOD

I. N. CARTE and L. E. ANTON (Polytechnic Inst., Timisoara, Romania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074) vol. 37, no. 5 Sept.-Oct. 1992 p. 581-591. refs

The design of a turbopump blade cascade requires knowledge of the hydrodynamic field in the axial plane from the machine bladed zone. This is given by the family of the stream surfaces and the velocity equal potential surfaces. Assuming that these surfaces are of a revolution type, the blade cascade geometry may be defined by the radial-axial profile cascade geometry placed on the revolution stream surfaces. This paper proposes the determination of the hydrodynamic field from the turbopump impeller zone using the finite element method based on the hypothesis of the axisymmetric motion of the incompressible ideal fluid. Author

A93-27065

CHARACTERISTIC MULTIGRID METHOD APPLICATION TO SOLVE THE EULER EQUATIONS WITH UNSTRUCTURED AND UNNESTED GRIDS

M. P. LECLERCQ and B. STOUFFLET (Dassault Aviation, Saint Cloud, France) Journal of Computational Physics (ISSN 0021-9991) vol. 104, no. 2 Feb. 1993 p. 329-346. refs Copyright

The novelty of the present multigrid method for the solution of hyperbolic systems of conservation laws in conjunction with higher-order upwind approximation lies in its introduction of an upwind transfer operator between two successive grids. After investigating the efficiency of the method for a scalar linear advection equation in 1D, on the basis of Fourier analysis, an extension to an unstructured multigrid method is proposed. Attention is given to numerical results for a hypersonic flow 2D simulation. O.C.

A93-27068

National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

UNIFORM HIGH-ORDER SPECTRAL METHODS FOR ONE- AND TWO-DIMENSIONAL EULER EQUATIONS

WEI CAI (North Carolina Univ., Charlotte) and CHI-WANG SHU (Brown Univ., Providence, RI) Journal of Computational Physics (ISSN 0021-9991) vol. 104, no. 2 Feb. 1993 p. 427-443. Previously announced in STAR as N91-21456 Research supported by North Carolina Supercomputer Center and Univ. of North Carolina refs (Contract NSF ASC-90-05874; NSF ASC-91-13895; NSF DMS-88-10150; NAG1-1145; AF-AFOSR-90-0093; NAS1-18605; RTOP 505-90-52-01)

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Uniform high order spectral methods to solve multi-dimensional Euler equations for gas dynamics are discussed. Uniform high order spectral approximations with spectral accuracy in smooth regions of solutions are constructed by introducing the idea of the Essentially Non-Oscillatory (ENO) polynomial interpolations into the spectral methods. The authors present numerical results for the inviscid Burgers' equation, and for the one-dimensional Euler equations including the interactions between a shock wave and density disturbance, Sod's and Lax's shock tube problems, and the blast wave problem. The interaction between a Mach 3 two-dimensional shock wave and a rotating vortex is simulated. Author

A93-27368

A TIME DEPENDENT METHOD IN FINITE VOLUME FOR TRANSONIC DIFFUSER TURBULENT FLOWS

SHU-CHENG ZHANG and XI-JUN HUANG (Beijing Univ. of Aeronautics and Astronautics, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 4 Nov. 1992 p. 258-263. Translation. Previously cited in issue 20, p. 3468, Accession no. A92-47690 refs Copyright

A93-27442

VISUALIZATION AND ANALYSIS OF SUPERSONIC FLOW IN ROTATING TURBINE STAGE. II - ANALYSIS OF THE FLOW INTO THE MOVING BLADES AND THEIR EXIT FLOW

MASASHI AKIBA, AKIHITO TODA, YOSHIO IWAMURA, and KAORU UNO Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58, no. 555 Nov. 1992 p. 3342-3346. In Japanese. refs

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The flow characteristics of the turbine stage, which runs at a high pressure ratio, are complicated by the appearance of shock and expansion waves. An exact numerical method by which to calculate the influence of such unsteady phenomena is impossible due to interaction and reflection of shock waves effected by the boundary layer. Therefore, flow visualization of the entire stage cascade on running was made by the Schlieren method employing a stroboscope, and a flow analysis was executed on the basis of the photograph's color. In addition, the pressure fluctuation at the stationary blade exit point was measured. Detached shock waves created in front of the moving blades could verify the influence on the cascade flow. Author

A93-27443

SURGING LIMITS OF MULTISTAGE AXIAL-FLOW COMPRESSORS

YOSHIMI NISHIHARA Japan Society of Mechanical Engineers,

Transactions B (ISSN 0387-5016) vol. 58, no. 555 Nov. 1992 p. 3352-3359. In Japanese. refs
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This paper describes the comparison between the experimental results and the analytical results for the surging limits of a multistage axial-flow compressor with a decompression suction chamber in front of the compressor. The analysis is based on the simplest two-element model for the compressor rotor flow passage, which is connected to the lumped parameter model extended to the decompression chamber. In this paper, it is shown that the surging limits are affected by the compressor discharge volume and the existence of the decompression system. Author

A93-27445

MICROCHANNEL PLATE MODAL GAIN VARIATIONS WITH TEMPERATURE

TAKENORI MATSUBARA, MASANORI TASHIMO, FUMIO KURE, TORU IITSUKA, NOBUYUKI YAMAGUCHI, and TOSHITAKA FUJIWARA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58, no. 556 Dec. 1992 p. 3653-3658. In Japanese. refs
Copyright

System concepts have been dealt with by applying the power augmented ram wing for large ground effect craft. Trend analysis and parametric studies on the effects of its dynamic stabilities have been conducted to evaluate some kinds of tandem wing craft. The necessary ranges and tendencies of the aerodynamic characteristics were determined for each of the systems of enhanced lift wings. By controlling the appropriate tail unit we achieved a simulation of the flare maneuvers. Author

A93-27474* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ON THE ACCURATE PREDICTION OF THE WALL-NORMAL VELOCITY IN COMPRESSIBLE BOUNDARY-LAYER FLOW

C. D. PRUETT (Analytical Services and Materials, Inc., Hampton, VA) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 16, no. 2 Jan. 30, 1993 p. 133-152. refs
(Contract NAS1-18599)
Copyright

A method for predicting the wall-normal velocity in compressible boundary layer flow is presented which is the extension of the fully implicit, spectral collocation method developed by Pruett and Streett (1991). The spectrally accurate method under consideration is capable of extracting the wall-normal velocity from the transformation from the physical plane to a computational plane, without interpolation, leaving the continuity equation free as a check on the quality of the solution. When used in conjunction with a highly accurate spectral collocation method for the compressible boundary-layer equations, the method gives a discrete solution which satisfies the continuity equation nearly to machine precision. O.G.

A93-27475

NUMERICAL EXPERIMENTS ON THE STABILITY OF LEADING EDGE BOUNDARY LAYER FLOW - A TWO-DIMENSIONAL LINEAR STUDY

VASSILIOS THEOFILIS (Twente Univ. of Technology, Enschede, Netherlands) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 16, no. 2 Jan. 30, 1993 p. 153-170. Research supported by SERC refs
Copyright

A numerical study is performed in order to gain insight to the stability of the infinite swept attachment line boundary layer. The basic flow is taken to be of the Hiemenz class with an added cross-flow giving rise to a constant thickness boundary layer along the attachment line. The full Navier-Stokes equations are solved using an initial value problem approach after two-dimensional perturbations of varying amplitude are introduced into the basic flow. A second-order-accurate finite difference scheme is used in the normal-to-the-wall direction, while a pseudospectral approach is employed in the other directions; temporally, an implicit Crank-Nicolson scheme is used. Extensive use of the efficient

fast Fourier transform (FFT) algorithm has been made, resulting in substantial savings in computing cost. Results for the two-dimensional linear regime of perturbations are in very good agreement with past numerical and theoretical investigations, without the need for specific assumptions used by the latter, thus establishing the generality of our method. Author

A93-27482

EXPERIMENTS ON A 60 DEG DELTA WING WITH VORTEX FLAPS AND VORTEX PLATES

K. RINOIE (Cranfield Inst. of Technology, United Kingdom) Aeronautical Journal (ISSN 0001-9240) vol. 97, no. 961 Jan. 1993 p. 33-38. Research supported by Science and Technology Agency of Japan refs
Copyright

Low speed wind tunnel tests have been made to investigate the flow around a leading edge vortex flap at the maximum L/D condition. Tests were also made to measure the performance of a vortex plate. The force measurements and flow visualization tests were conducted on a 0.53 m span 60 deg delta wing model. Results indicate that the L/D ratio is a maximum for any given flap deflection angle at which the flow comes smoothly onto the deflected vortex flap without forming a large leading edge separation vortex on the flap surface. The benefit of the vortex plate is seen in the drag results, which are smaller than those for the datum wing. This benefit is due to leading edge suction acting on the forward facing region between the delta wing and the vortex plate. Author

A93-27605

SHOCK WAVE AHEAD OF A LIQUID JET IN SUPERSONIC CROSS FLOW [UDARNAIA VOLNA PERED STRUEI ZHIDKOSTI V SVERKHZVUKOVOM SNOSIASHCHEM POTOKE]

S. I. BARANOVSKII and D. M. DAVIDENKO Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 21-24. In Russian. refs
Copyright

A model is proposed for calculating the shape and deflection of a shock wave ahead of a liquid jet that is normal to the supersonic cross flow. Empirical computational formulas are obtained using the available experimental data. Results of calculations are presented. V.L.

A93-27607

CALCULATION OF THREE-DIMENSIONAL SUPERSONIC FLOW PAST LIFTING SURFACES [K RASCHETU PROSTRANSTVENNOGO OBTEKANIIA NESUSHCHIKH POVERKHNOSTEI SVERKHZVUKOVYM POTOKOM]

S. S. GRAS'KIN Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 27-32. In Russian. refs
Copyright

The possibility of using the discrete vortex method for solving the problem of three-dimensional supersonic flow past lifting surfaces is examined. A mathematical validation of the discrete vortex method when applied to problems in supersonic aerodynamics is presented. The analysis presented here allows for singularities at compression shocks. V.L.

A93-27614

PROBLEMS IN THE OPTIMUM DESIGN OF A WING PROFILE FOR NONSEPARATED FLOW OVER A RANGE OF ANGLES OF ATTACK [ZADACHI OPTIMAL'NOGO PROEKTIROVANIIA KRYLOVOGO PROFILIA PRI BEZOTRYVNOB OBTEKANII V DIAPAZONE UGLOV ATAKI]

E. V. FEDOROV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 55-59. In Russian. refs
Copyright

Solutions are presented for optimization problems involving the determination of the shape of nonporous wing profiles of maximum lifting capacity, minimum drag, and maximum lift-drag ratio in nonseparated flow over a range of angles of attack, with additional constraints imposed on the aerodynamic characteristics of the

profiles. Attention is given to the case where the range bounds are the optimization parameters. Examples of optimized profiles are presented. V.L.

A93-27624

WAVE RESISTANCE OF SWEEPED WINGS WITH SUPERSONIC EDGES [VOLNOVOE SOPROTVIVLENIE SKOL'ZIASHCHIKH KRYL'EV SO SVERKHZVUKOVYMI KROMKAMI]

O. P. SIDOROV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 91-95. In Russian. refs

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The performance of straight and swept wings with supersonic edges is compared in terms of their wave resistance. It is shown that, depending on the relative thickness ratio, the wave resistance coefficient of swept wings, over certain Mach number ranges, may be higher or lower than that of straight wings. V.L.

A93-27636

THREE-DIMENSIONAL FLOW PAST AN OGIVAL-CYLINDRICAL BODY IN COMBINATION WITH A DELTA WING [PROSTRANSTVENNOE OTEKANIE OZHIVAL'NO-TSILINDRICHESKOGO TELA V KOMBINATSII S TREUGOL'NYM KRYLOM]

L. G. VASENEV and A. M. KHARITONOV (RAN, Inst. Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, Russia) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339) no. 5 Sept.-Oct. 1992 p. 56-67. In Russian. refs

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The effect of a thin delta wing on the aerodynamics of an ogival-cylindrical body of revolution was investigated in a supersonic wind tunnel. The data obtained explain the mechanism of the wing effect on the flow characteristics of the windward and leeward sides of the body, including the rear part. The relationship between the flow pattern around the body and the surface pressure distribution is investigated, and the normal-force aerodynamic coefficients are calculated. It is shown that the lift of the body can be increased several-fold by appropriately varying the area of the wing and the place of its attachment to the body. L.M.

A93-27639

EXPERIENCE WITH THE USE OF LIQUID CRYSTALS IN CONJUNCTION WITH THE FILAMENT METHOD IN STUDYING THE STRUCTURE OF SUPERSONIC FLOW DOWNSTREAM OF A PLANE STEP [OPYT PRIMENENIIA ZHIDKIKH KRISTALLOV V KOMPLEKSE S METODOM NITEI PRI IZUCHENII STRUKTURY SVERKHZVUKOVOGO TECHENIIA ZA PLOSKIM USTUPOM]

V. M. TROFIMOV, S. I. SHTREKALKIN, and S. V. NAUMENKO (RAN, Inst. Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, Russia) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339) no. 5 Sept.-Oct. 1992 p. 85-91. In Russian. refs

Copyright

Liquid-crystal thermal indicators were used in conjunction with the filament method to investigate longitudinal vortex structures of the Taylor-Görtler kind in the boundary layer reattached downstream of a plane step with a view to obtaining more information about the temperature field and the field of mean velocity vectors. The high sensitivity of liquid-crystal thermal indicators made it possible to detect temperature gradients as small as 2 K and to identify the details of complex separated flows with longitudinal vortices. The characteristic regions of separated flow beyond the plane step are determined, and large-scale three-dimensional effects are identified, as are other details of the flow structure. V.L.

A93-27922

PHYSICS OF FORCED UNSTEADY FLOW FOR A NACA 0015 AIRFOIL UNDERGOING CONSTANT-RATE PITCH-UP MOTION

K. N. GHIA, J. YANG, G. A. OSSWALD, and U. GHIA (Cincinnati Univ., OH) Fluid Dynamics Research (ISSN 0169-5983) vol. 10, no. 4-6 Dec. 1992 p. 351-369. Research supported by Ohio Supercomputer Center refs

(Contract AF-AFOSR-90-0249)

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The unsteady Navier-Stokes (NS) analysis of Osswald, Ghia and Ghia in velocity-vorticity variables is modified to study the dynamic stall phenomenon for a NACA 0015 airfoil undergoing constant $\Omega(0)$ pitch-up maneuvers at Reynolds number $Re = 10,000$ and $45,000$. The fully implicit and vectorized ADI-BGE method of the authors is used to solve the unsteady NS equations. Instantaneous inertial surface vorticity, which is an invariant of the choice of reference frame selected, is employed to determine the location of separation of the boundary-layer flow on the suction surface; also a separation bubble embedded within the boundary layer is observed for both cases somewhere between the leading edge and the quarter-chord point. Primary, secondary, tertiary and quaternary vortices have been observed before the dynamic-stall vortex evolves and gathers its maximum strength. Author

A93-27924*

National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

INVESTIGATION OF VORTEX BREAKDOWN ON DELTA WINGS USING NAVIER-STOKES EQUATIONS

C.-H. HSU (Vigyan, Inc., Hampton, VA) and C. H. LIU (NASA, Langley Research Center, Hampton, VA) Fluid Dynamics Research (ISSN 0169-5983) vol. 10, no. 4-6 Dec. 1992 p. 399-408. refs

(Contract NAS1-18585)

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An efficient finite-difference scheme solving for the three-dimensional incompressible Navier-Stokes equations is described. Numerical simulations of vortex breakdown are then carried out for a sharp-edged delta wing and a round-edged double-delta wing at high Reynolds numbers. Computed results show that several major features of vortex breakdown are qualitatively in agreement with observations made in experiments. Author

A93-27925*

National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PREDICTION OF ASYMMETRIC VORTICAL FLOWS AROUND SLENDER BODIES USING NAVIER-STOKES EQUATIONS

C. H. LIU (NASA, Langley Research Center, Hampton, VA), TIN-CHEE WONG, and OSAMA A. KANDIL (Old Dominion Univ., Norfolk, VA) Fluid Dynamics Research (ISSN 0169-5983) vol. 10, no. 4-6 Dec. 1992 p. 409-450. refs

(Contract NAG1-994)

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Steady and unsteady asymmetric vortical flows around slender bodies at high angles of attack are solved using the unsteady, compressible, thin-layer Navier-Stokes equations. An implicit, upwind-biased, flux-difference splitting, finite-volume scheme is used for the numerical computations. For supersonic flows past point cones, the locally conical flow assumption have been used for efficient computational studies of this phenomenon. Asymmetric flows past a 5-deg semiapex-angle circular cone at different angles of attack, free-stream Mach numbers, and Reynolds numbers have been studied in responses to different sources of disturbances. The effects of grid fineness and computational domain size have also been investigated. Next, the responses of three-dimensional supersonic asymmetric flow around a 5-deg circular cone at different angles of attack and Reynolds numbers to short-duration sideslip disturbances are presented. The results show that flow asymmetry becomes stronger as the Reynolds number and angles of attack are increased. One of the cases of flow over a cone-cylinder configuration is validated fairly well by experimental data. Author

A93-27926

HYPERSONIC VISCOUS FLOW SIMULATIONS

W. KORDULLA, S. RIEDELBAUCH, G. BRENNER, and U. PRINZ (DLR, Inst. fuer Theoretische Stromungsmechanik, Goettingen, Germany) Fluid Dynamics Research (ISSN 0169-5983) vol. 10, no. 4-6 Dec. 1992 p. 451-468. Research supported by DFG,

Dassault Aviation, and CNES refs
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Computational work in continuum hypersonics and, in particular, the difficulties encountered during the development of the methods at the DLR Institute for Theoretical Fluid Mechanics are presented. Finite-difference schemes with implicit-explicit central discretization and shock fitting and with upwind-TVD formulation and shock capturing are discussed, e.g., for strong shock-shock interactions. 3D flows of perfect gas at large angle of attack are considered, including those with radiation-adiabatic surface boundary conditions. 2D or axisymmetric as well as 3D flows in thermochemical equilibrium are simulated using either the Tannehill curve-fitting approach for air or the minimization procedure for Gibbs' free energy which is more general at the expense of larger cost. Nonequilibrium flow simulation are discussed for axisymmetric nitrogen and air model flows. With the help of an appropriate model equation for finite-rate chemistry it is shown that the usual Harten-Yee approach does not allow to propagate shock waves in a time-accurate fashion if large source terms are present.

Author

A93-28518

FLUID FLOWS AROUND CASCADES

D. B. INGHAM and B. YAN (Leeds Univ., United Kingdom) Zeitschrift fuer angewandte Mathematik und Physik (ISSN 0044-2275) vol. 44, no. 1 Jan. 1993 p. 53-72. refs

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Flows induced by the small-amplitude and high frequency harmonic oscillations of a cascade of bodies in an unbounded fluid which is otherwise at rest are investigated theoretically. In the theoretical study we separate the flow into inner and outer regions. The flow in the inner region is governed by the Stokes boundary-layer equation. The first-order outer flow is governed by the potential solution which is found by using a conformal mapping technique. The second-order outer flow is governed by the full Navier-Stokes equation, and the steady streaming flow has been obtained using a modified central-difference scheme for cascades with square cylinders and flat plates for values of the streaming Reynolds number up to 70. These results show a complicated flow structure.

Author

A93-28544

SUBSONIC POTENTIAL FLOW AND THE TRANSONIC CONTROVERSY

A. J. GUTTMANN and C. J. THOMPSON (Melbourne Univ., Parkville, Australia) SIAM Journal on Applied Mathematics (ISSN 0036-1399) vol. 53, no. 1 Feb. 1993 p. 48-59. Research supported by Australian Research Council refs

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The two problems of a 2D flow of an inviscid, compressible, perfect diatomic gas past a circular cylinder and past a sinusoidal wall are considered in this paper. It is shown that in both cases the coefficients of the maximum speed series can be interpreted as moments with positive weight on a finite support. From the behavior of the moments, the underlying weight function is identified. Subsequent analysis then enables estimation of the radius of convergence of the moment-generating function subject to certain assumptions concerning the continued monotonic behavior of sequences. In both cases, this is found to be indistinguishable from the critical value of the appropriate expansion parameter. Thus assuming that the limits of convergence of the Janzen-Rayleigh expansion correspond to the limits of continuous irrotational flow, it would be argued for the negative side in the long-standing debate as to whether an airfoil can have a continuous range of smooth, shock-free potential flows above the critical Mach number.

Author

A93-28574

NUMERICAL STUDY ON THE INTERACTION OF SUPERSONIC FLOW PAST A WEDGE AND FREE JET

TAKEO SOGA and KOUJI YAMANAKA (Nagoya Univ., Japan) Nagoya University, Faculty of Engineering, Memoirs (ISSN 0027-7657) vol. 43, no. 1 1991 p. 121-134. refs

A supersonic flow past a swept or unswept ramp with the free jet ejected from the ramp end is simulated numerically employing the Piecewise Linear Method within the framework of the Euler equation. Results of simulation in the two-dimensional flow configuration predicted that a reflected shock wave interacted with the free jet resulting a pressure disturbance in the flow. Results of the simulation for the swept ramp predicted that a spiral flow emerged from the ramp-side involved the free jet resulting in a pair of unified intensive vortices. This vortex stretched the fuel jet crosswise and lifted it up. Such a stretching motion of the vortex effected the increase of the contact surface of the main flow and free jet, i.e., air and fuel. Thus the effectiveness of the swept ramp injector for the mixing enhancement of fuel-air was asserted. Further studies based on the Navier-Stokes equation is necessary, which will reveal whether or not the pair of vortices is stationary.

Author

A93-28601* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STABILITY THEORY AND TRANSITION PREDICTION APPLIED TO A GENERAL AVIATION FUSELAGE

R. E. SPALL (South Alabama Univ., Mobile, AL) and Y.-S. WIE (High Technology Corp., Hampton, VA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 161-167. refs (Contract NAS1-18240)

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The linear stability of a fully three-dimensional boundary layer formed over a general aviation fuselage was investigated. The location of the onset of transition was estimated using the N-factor method. The results were compared with existing experimental data and indicate N-factors of approximately 8.5 on the side of the fuselage and 3.0 near the top. Considerable crossflow existed along the side of the body, which significantly affected the unstable modes present in the boundary layer. Fair agreement was found between the predicted frequency range of linear instability modes and available experimental data concerning the spectral content of the boundary layer.

Author

A93-28604* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EULER STUDY ON POROUS TRANSONIC AIRFOILS WITH A VIEW TOWARD MULTIPOINT DESIGN

PETER M. HARTWICH (Vigyan, Inc., Hampton, VA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 184-191. Previously cited in issue 23, p. 4003, Accession no. A91-53786 refs (Contract NAS1-18585)

A93-28605

LAMINAR-FLOW INSTRUMENTATION FOR WIND-TUNNEL AND FLIGHT EXPERIMENTS

WOLFGANG NITSCHKE (Berlin Technical Univ., Germany) and JOACHIM SZODRUCH (Airbus Industrie, Blagnac, France) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 192-200. Previously cited in issue 09, p. 1305, Accession no. A91-24327 Research supported by BMFT refs

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A93-28606

POTENTIAL HAZARD OF AIRCRAFT WAKE VORTICES IN GROUND EFFECT WITH CROSSWIND

ROBERT E. ROBINS and DONALD P. DELISI (Northwest Research Associates, Inc., Bellevue, WA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 201-206. Previously cited in issue 21, p. 3259, Accession no. A89-49099 Research supported by Northwest Research Associates, Inc refs

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A93-28607

EXPERIMENTAL AND NONLINEAR VORTEX LATTICE METHOD RESULTS FOR VARIOUS WING-CANARD CONFIGURATIONS

J. ROM, B. MELAMED, and D. ALMOSNINO (Technion - Israel

02 AERODYNAMICS

Inst. of Technology, Haifa) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 207-212. Previously cited in issue 09, p. 1306, Accession no. A91-24355 refs Copyright

A93-28608 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SCHLIEREN STUDIES OF COMPRESSIBILITY EFFECTS ON DYNAMIC STALL OF TRANSIENTLY PITCHING AIRFOILS

M. S. CHANDRASEKHARA (U.S. Naval Postgraduate School, Monterey, CA), S. AHMED (MCAT Inst., San Jose; U.S. Navy-NASA, Joint Inst. of Aeronautics, Monterey, CA), and L. W. CARR (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 213-220. Previously cited in issue 21, p. 3287, Accession no. A90-45877 Research supported by U.S. Navy refs (Contract AF-AFOSR-87-0029) Copyright

A93-28610* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

SOLUTION-ADAPTIVE AND QUALITY-ENHANCING GRID GENERATION

PHU V. LUONG (Mississippi State Univ., Mississippi State; U.S. Navy, Naval Oceanographic Office, Bay Saint Louis, MS), JOE F. THOMPSON, and BOYD GATLIN (Mississippi State Univ., Mississippi State) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 227-234. Previously cited in issue 17, p. 2850, Accession no. A91-40767 refs (Contract NAS8-36949; F08635-89-C-0209) Copyright

A93-29153* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL STUDY OF THE FLOW ESTABLISHMENT TIME IN HYPERSONIC SHOCK TUNNELS

J. Y. LEE and M. J. LEWIS (Maryland Univ., College Park) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 30, no. 2 Mar.-Apr. 1993 p. 152-163. Previously cited in issue 18, p. 3055, Accession no. A91-43604 Research supported by NASA refs Copyright

A93-29155* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

GOERTLER INSTABILITY AND HYPERSONIC QUIET NOZZLE DESIGN

FANG-JENQ CHEN, STEPHEN P. WILKINSON (NASA, Langley Research Center, Hampton, VA), and IVAN E. BECKWITH (George Washington Univ., Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 30, no. 2 Mar.-Apr. 1993 p. 170-175. Previously cited in issue 17, p. 2856, Accession no. A91-42542 refs Copyright

A93-29175 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CURRENT STATUS OF COMPUTATIONAL METHODS FOR TRANSONIC UNSTEADY AERODYNAMICS AND AEROELASTIC APPLICATIONS

J. W. EDWARDS and J. B. MALONE (NASA, Langley Research Center, Hampton, VA) Computing Systems in Engineering (ISSN 0956-0521) vol. 3, no. 5 Oct. 1992 p. 545-569. Previously announced in STAR as N92-21432 refs (Contract RTOP 505-63-50-12) Copyright

The current status of computational methods for unsteady aerodynamics and aeroelasticity is reviewed. The key features of challenging aeroelastic applications are discussed in terms of the flowfield state: low-angle high speed flows and high-angle vortex-dominated flows. The critical role played by viscous effects in determining aeroelastic stability for conditions of incipient flow separation is stressed. The need for a variety of flow modeling

tools, from linear formulations to implementations of the Navier-Stokes equations, is emphasized. Estimates of computer run times for flutter calculations using several computational methods are given. Application of these methods for unsteady aerodynamic and transonic flutter calculations for airfoils, wings, and configurations are summarized. Finally, recommendations are made concerning future research directions. Author

A93-29307

FLOWFIELD MEASUREMENTS OF A TWO-ELEMENT AIRFOIL WITH LARGE SEPARATION

KASIM BIBER and GLEN W. ZUMWALT (Wichita State Univ., KS) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 459-464. Previously cited in issue 09, p. 1347, Accession no. A92-25723 refs Copyright

A93-29316

COMPRESSIBLE FLOW IN A HOVERCRAFT AIR CUSHION

A. POZZI, F. MANZO, and P. LUCHINI (Napoli, Univ., Naples, Italy) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 528-533. refs Copyright

A solution of the compressible fluid-dynamic equations describing the two-dimensional, inviscid, subsonic fluid-dynamic field in the peripheral jets of a hovercraft at zero forward speed is presented. The analysis is made in the hodograph plane in which the motion equation is linear and enables one to write the solution of the problem as a sum of elementary separable solutions of the equation. The stream function is expressed as a Fourier series whose coefficients can be calculated numerically with ease. The comparison of the results with those of a different representation, valid only in the incompressible case, shows that the two solutions coincide. The calculation of quantities of interest for several values of the parameters characterizing the problem enabled us to evaluate the influence of the compressibility that, for high subsonic Mach numbers of the jet, is at most on the order of magnitude of 20 percent. Author

A93-29318* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

LINEARIZED EULER PREDICTIONS OF UNSTEADY AERODYNAMIC LOADS IN CASCADES

KENNETH C. HALL and WILLIAM S. CLARK (Duke Univ., Durham, NC) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 540-550. Previously cited in issue 18, p. 3062, Accession no. A91-44318 refs (Contract NAG3-1192) Copyright

A93-29326

STRUCTURE-ATTACHED COROTATIONAL FLUID GRID FOR TRANSIENT AEROELASTIC COMPUTATIONS

C. FARHAT and T. Y. LIN (Colorado Univ., Boulder) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 597-599. Previously cited in issue 21, p. 3292, Accession no. A90-45932 refs Copyright

A93-29411* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SHOCK WAVES AND THE FLOW WILLIAMS-HAWKINGS EQUATION

MORRIS P. ISOM (Polytechnic Univ., Brooklyn, NY) and YUNG H. YU (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA) In AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 20 p. Research supported by U.S. Army refs (Contract NCC2-172) Copyright

The expansion of the double divergence of the generalized

Lighthill stress tensor, which is the basis of the concept of the role played by shock and contact discontinuities as sources of dipole and monopole sound, is presently applied to the simplest transonic flows: (1) a fixed wing in steady motion, for which there is no sound field, and (2) a hovering helicopter blade that produces a sound field. Attention is given to the contribution of the shock to sound from the viewpoint of energy conservation; the shock emerges as the source of only the quantity of entropy. O.C.

A93-29432

EXPERIMENTAL STUDY OF A SINGLE STRONG VORTEX-AIRFOIL INTERACTION

WITOLD ST. KAMINSKI (Inst. of Aviation, Warsaw, Poland) and ANDRZEJ P. SZUMOWSKI (Warsaw Univ. of Technology, Poland) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p.

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A shock tube apparatus is presently used to conduct a 2D airfoil-vortex interaction experiment, with a view to the aerodynamic behavior of a NACA 0012 profile airfoil during a parallel interaction at Mach 0.54 and various angles of attack. Schlieren visualizations and pressure measurements are obtained. A strong dependency of the phenomenon on angle of attack and vortex rotation direction is noted. O.C.

A93-29434 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE DEVELOPMENT OF A CFD POTENTIAL METHOD FOR THE ANALYSIS OF TILT-ROTORS

JOHN O. BRIDGEMAN (Woodside Summit Group, Inc., Mountain View, CA), DEVON PRICHARD (NASA, Langley Research Center, Hampton, VA), and FRANCIS X. CARADONNA (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. refs

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A new CFD potential code, FPX (eXtended Full-Potential), has been developed for application to both helicopters and tilt-rotors. The code solves the unsteady, three-dimensional full potential equation and is an extension of the rotor code, FPR. Both entropy and viscosity corrections are included to enhance the physical modeling capabilities. A number of efficiency related modifications have yielded a factor of two speed-up in the code. An axial flow capability has been added to treat tilt-rotor in forward flight (cruise mode). In order to employ streamwise periodicity and accurately solve for the propagation of acoustic signals in the tip region, an H-H topology has been added to the basic O-H grid system. Computations are performed for the XV-15 Standard and ATB blades at high-speed conditions. Comparisons are made for the blade aerodynamics and the induced fuselage cabin pressure for a range of Mach numbers. Grid generation, wake treatment, and far-field wall treatment are identified as problem areas with recommendations for future research. Author

A93-29435* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FLOWFIELD ANALYSIS OF MODERN HELICOPTER ROTORS IN HOVER BY NAVIER-STOKES METHOD

G. R. SRINIVASAN (JAI Associates, Inc.; NASA, Ames Research Center, Moffett Field, CA), V. RAGHAVAN (Sterling Federal Systems; NASA, Ames Research Center, Moffett Field, CA), and E. P. N. DUQUE (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 18 p. Previously announced in STAR as N92-21333

refs

(Contract DAAL03-90-C-0013)

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The viscous, three-dimensional, flowfields of UH60 and BERP rotors are calculated for lifting hover configurations using a Navier-Stokes computational fluid dynamics method with a view to understand the importance of planform effects on the airloads. In this method, the induced effects of the wake, including the interaction of tip vortices with successive blades, are captured as a part of the overall flowfield solution without prescribing any wake models. Numerical results in the form of surface pressures, hover performance parameters, surface skin friction and tip vortex patterns, and vortex wake trajectory are presented at two thrust conditions for UH60 and BERP rotors. Comparison of results for the UH60 model rotor show good agreement with experiments at moderate thrust conditions. Comparison of results with equivalent rectangular UH60 blade and BERP blade indicates that the BERP blade, with an unconventional planform, gives more thrust at the cost of more power and a reduced figure of merit. The high thrust conditions considered produce severe shock-induced flow separation for UH60 blade, while the BERP blade develops more thrust and minimal separation. The BERP blade produces a tighter tip vortex structure compared with the UH60 blade. These results and the discussion presented bring out the similarities and differences between the two rotors. Author

A93-29436

A NUMERICAL STUDY OF ADVANCED ROTOR BLADES

G. ABDY and V. WELLS (Arizona State Univ., Tempe) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 12 p. refs

(Contract DAAL03-90-G-0221)

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The paper describes the methodology for and results from a study of rotor blades with advanced planforms, in particular, that of the BERP blade. The study utilizes a code developed to solve the Reynolds-Averaged Navier-Stokes equations for a surface in arbitrary motion. The motions considered include rotation, translation (forward flight), pitching (feathering), and plunging (flapping). Through the code can handle more complex and realistic cases, results presented here are restricted to those for a rigid blade, with prescribed feathering and flapping dynamics. The paper presents results of the computations for a rotor blade with a BERP tip and with two different airfoil geometries. Flight regimes include rectilinear flight, hover, and forward flight at high and low angles of attack and with and without feathering and flapping. Results shown include pressure distributions on the blades and velocity fields in the blade vicinity. Author

A93-29437* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RECENT DEVELOPMENTS IN ROTOR WAKE MODELING FOR HELICOPTER NOISE PREDICTION

D. POLING, L. DADONE (Boeing Helicopters, Philadelphia, PA), and S. ALTHOFF (NASA, Langley Research Center, Hampton, VA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 16 p. refs

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A preliminary test/theory correlation evaluation is conducted for wake measurement test results obtained by LDV for a B360 helicopter rotor, at conditions critical to the understanding of wake-rollup and blade-vortex interaction phenomena. The LDV data were complemented by acoustic, blade pressure, rotor performance, and blade/control load measurements. O.C.

A93-29438* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

CORRELATION OF AIRLOADS ON A TWO-BLADED HELICOPTER ROTOR

FRANCISCO HERNANDEZ (NASA, Ames Research Center, Moffett Field, CA) and WAYNE JOHNSON (Johnson Aeronautics, Palo Alto, CA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 38 p. refs

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Airloads measured on a two-bladed helicopter rotor in flight, from the Tip Aerodynamic and Acoustic Test, are compared with calculations from a comprehensive helicopter analysis (CAMRAD/JA), and the pressures compared with calculations from a full-potential rotor code (FPR). The flight test results cover an advance ratio range from 0.19 to 0.38. The lowest speed case is characterized by the presence of significant blade-vortex interactions. Good correlation of peak-to-peak vortex-induced loads and the corresponding pressures is obtained. The results of the correlation for this two-bladed rotor are substantially similar to the results for three- and four-bladed rotors, concerning the tip vortex core size for best correlation, calculation of the peak-to-peak loads on the retreating side, and calculation of vortex-induced loads on inboard radial stations. Author

A93-29440

PASSIVE DRAG REDUCTION OF A HELICOPTER AIRFOIL IN AN UNSTEADY TRANSONIC FLOW

H. T. NAGAMATSU, A. D. FEINGOLD (Rensselaer Polytechnic Inst., Troy, NY), R. R. SMITH (Case Western Reserve Univ., Cleveland, OH), and M. A. WESTON (Timken Bearing, Inc., Canton, OH) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. Research supported by U.S. Army refs

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Unsteady passive transonic airfoil drag reduction is currently being investigated in the Rensselaer 3 x 8-inch Blowdown Transonic Wind Tunnel. A hollow cavity has been placed beneath a porous surface Bell FX69-H-098 airfoil in the region of the shock wave formation. Past experiments have shown that in a steady transonic flow over an airfoil with a porous surface a lambda shaped shock wave will form resulting in a thinner boundary layer and a weaker shock wave. Steady state drag reductions as much as 33 percent at Mach 0.86 were observed. These results should translate directly into reductions in the noise and the power. The current research is aimed at testing the system in an unsteady flow oscillating between Mach number of 0.45 and Mach 0.84 at a 5 Hz frequency, replicating a helicopter rotor airfoil in flight. A computer data acquisition system is being implemented to fully describe the flow over an airfoil in unsteady flow. Results have shown that a drag reduction of approximately 15 percent can be accomplished through the implementation of the passive drag reduction concept. Author

A93-29441* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FLOW VISUALIZATION AND FLOW FIELD MEASUREMENTS OF A 1/12 SCALE TILT ROTOR AIRCRAFT IN HOVER

CHARLES D. COFFEN, ALBERT R. GEORGE, HAL HARDINGE, and RYAN STEVENSON (Cornell Univ., Ithaca, NY) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 29 p. Previously announced in STAR as N92-11983 Research supported by Cornell Univ. refs (Contract NAG2-554)

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The results are given of flow visualization studies and inflow velocity field measurements performed on a 1/12 scale model of the XV-15 tilt rotor aircraft in the hover mode. The complex recirculating flow due to the rotor-wake-body interactions characteristic of tilt rotors was studied visually using neutrally buoyant soap bubbles and quantitatively using hot wire anemometry. Still and video photography were used to record the

flow patterns. Analysis of the photos and video provided information on the physical dimensions of the recirculating fountain flow and on details of the flow including the relative unsteadiness and turbulence characteristics of the flow. Recirculating flows were also observed along the length of the fuselage. Hot wire anemometry results indicate that the wing under the rotor acts to obstruct the inflow causing a deficit in the inflow velocities over the inboard region of the model. Hot wire anemometry also shows that the turbulence intensities in the inflow are much higher in the recirculating fountain reingestion zone. Author

A93-29774* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

FINITE ELEMENT COMPUTATION OF COMPRESSIBLE FLOWS WITH THE SUPG FORMULATION

G. J. LE BEAU (NASA, Johnson Space Center, Houston, TX) and T. E. TEZDUYAR (Minnesota Univ., Minneapolis) *In* Advances in finite element analysis in fluid dynamics - 1991; Proceedings of the Symposium, ASME Winter Annual Meeting, Atlanta, GA, Dec. 1-6, 1991 New York American Society of Mechanical Engineers 1991 p. 21-27. Research sponsored by Univ. of Minnesota and U.S. Army refs

(Contract NAG9-449; NSF MSM-87-96352)

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Finite element computation of compressible Euler equations is presented in the context of the streamline-upwind/Petrov-Galerkin (SUPG) formulation. The SUPG formulation, which is based on adding stabilizing terms to the Galerkin formulation, is further supplemented with a shock capturing operator which addresses the difficulty in maintaining a satisfactory solution near discontinuities in the solution field. The shock capturing operator, which has been derived from work done in entropy variables for a similar operator, is shown to lead to an appropriate level of additional stabilization near shocks, without resulting in excessive numerical diffusion. An implicit treatment of the impermeable wall boundary condition is also presented. This treatment of the no-penetration condition offers increased stability for large Courant numbers, and accelerated convergence of the computations for both implicit and explicit applications. Several examples are presented to demonstrate the ability of this method to solve the equations governing compressible fluid flow. Author

A93-29780

COMPRESSOR SURGE AND STALL

RONALD C. PAMPREEN Norwich, VT Concepts ETI, Inc. 1993 457 p. refs

(ISBN 0-933283-05-9) Copyright

The book deals with compressor surge and stall in terms of physical descriptions, test results, and analytical studies. Attention is given to the concept of compressor instability; the definition of stall, aerodynamic behavior in stall, measurements taken within stall cells, and results of investigations into stall inception; and correlations on annulus blockage, cell number, and propagation velocity. Surge and data for axial and centrifugal compressors; multistage compressors; surge and stall theories; and methods for extending useful flow range are also examined. O.G.

N93-19921# Industrie Aeronautiche e Meccaniche Rinaldo Piaggio S.p.A., Genoa (Italy).

NATURAL LAMINAR FLOW TEST IN-FLIGHT VISUALIZATION

G. SACCO, P. CINQUETTI, and S. MARTINI *In* AGARD, Flight Testing 8 p Oct. 1992

Copyright Avail: CASI HC A02/MF A04

This paper presents an overview of the test campaign performed on the Piaggio P.180 'Avanti' aircraft in order to develop and obtain the maximum natural laminar flow on the lifting surfaces. The paper reports the development of new profile family that could allow not only good laminar flow characteristics in the aircraft flight envelope but also favorable pressure distribution and performance results. The wind tunnel and in-flight visualization as well as the effects of natural laminar flow airfoil contamination are herein described. Sublimating chemicals techniques have been employed to test the design airfoils even if this approach allowed

only one test point per flight. Positive results were however achieved and demonstrated the positive effects of such a design philosophy. Author

N93-20017 Department of the Navy, Washington, DC.
AERODYNAMIC SURFACE TIP VORTEX ATTENUATION SYSTEM Patent

ROBERT M. TAYLOR, inventor (to Navy) 27 Oct. 1992 12 p
 Filed 16 Nov. 1990
 (AD-D015606; US-PATENT-5,158,251;
 US-PATENT-APPL-SN-614411) Avail: US Patent and Trademark Office

Apparatus and method for attenuating fluid foil tip vortices, featuring a 'Coanda tip' and a 'Coanda curtain' are discussed. The fluid foil tip has a Coanda surface and means for discharging compressed fluid adjacent thereto; a resultant fluid barrier is formed generally chordwise and perpendicular to the fluid foil plane and tangential to the fluid foil tip upon Coanda entrainment and deflection of the discharged compressed fluid. The fluid barrier prevents crossflow from the higher pressure fluid region to the lower pressure fluid region, the fluid regions being separated by the fluid foil when moving relatively through a fluid, the fluid barrier thereby stemming tip vortex generation at its source. GRA

N93-20018* Rice Univ., Houston, TX. Dept. of Mechanical Engineering and Materials Science.

THE SEMI-DISCRETE GALERKIN FINITE ELEMENT MODELLING OF COMPRESSIBLE VISCOUS FLOW PAST AN AIRFOIL Final Technical Report, 1 Jan. - 31 Dec. 1992

ANDREW J. MEADE, JR. 31 Dec. 1992 80 p
 (Contract NAG1-1196)
 (NASA-CR-192161; NAS 1.26:192161) Avail: CASI HC A05/MF A01

A method is developed to solve the two-dimensional, steady, compressible, turbulent boundary-layer equations and is coupled to an existing Euler solver for attached transonic airfoil analysis problems. The boundary-layer formulation utilizes the semi-discrete Galerkin (SDG) method to model the spatial variable normal to the surface with linear finite elements and the time-like variable with finite differences. A Dorodnitsyn transformed system of equations is used to bound the infinite spatial domain thereby permitting the use of a uniform finite element grid which provides high resolution near the wall and automatically follows boundary-layer growth. The second-order accurate Crank-Nicholson scheme is applied along with a linearization method to take advantage of the parabolic nature of the boundary-layer equations and generate a non-iterative marching routine. The SDG code can be applied to any smoothly-connected airfoil shape without modification and can be coupled to any inviscid flow solver. In this analysis, a direct viscous-inviscid interaction is accomplished between the Euler and boundary-layer codes, through the application of a transpiration velocity boundary condition. Results are presented for compressible turbulent flow past NACA 0012 and RAE 2822 airfoils at various freestream Mach numbers, Reynolds numbers, and angles of attack. All results show good agreement with experiment, and the coupled code proved to be a computationally-efficient and accurate airfoil analysis tool.

Author (revised)

N93-20169* George Washington Univ., Washington, DC. School of Engineering and Applied Science.

SHOCK-DEPENDENT, OPTIMUM THRUST WINGS IN SUPERSONIC FLOW Ph.D. Thesis

JAMES LEE PITTMAN 21 Dec. 1992 141 p
 Avail: CASI HC A07/MF A02

A new wing concept that reduces the inviscid drag of a wing in supersonic flow is presented. This wing concept utilizes a secondary shock that occurs aft of the maximum thickness location to produce a significant aerodynamic thrust force from the aft portion of the wing, thereby reducing the inviscid drag. The increased aft-wing thrust force is created by contouring each streamwise airfoil aft of the maximum thickness location to obtain a more favorable orientation of the local wing surface. The

aerodynamic thrust force has generally been associated with the near leading-edge region of a wing previously. The secondary shock is clearly identified and favorably exploited herein for the first time. Dissert. Abstr.

N93-20235* MCAT Inst., San Jose, CA.
TURBULENCE MODELING FOR HYPERSONIC FLIGHT Final Report

JORGE E. BARDINA Feb. 1993 32 p
 (Contract NCC2-585)
 (NASA-CR-192288; NAS 1.26:192288; MCAT-93-07) Avail: CASI HC A03/MF A01

The objective of the proposed work is to continue to develop, verify, and incorporate the baseline two-equation turbulence models, which account for the effects of compressibility at high speeds, into a three-dimensional Reynolds averaged Navier-Stokes (RANS) code. Additionally, we plan to provide documented descriptions of the models and their numerical procedures so that they can be implemented into the NASP CFD codes.

Derived from text

N93-20256* Computational Mechanics Co., Austin, TX.
ADVANCED ADAPTIVE COMPUTATIONAL METHODS FOR NAVIER-STOKES SIMULATIONS IN ROTORCRAFT AERODYNAMICS

S. T. STOWERS, J. M. BASS, and J. T. ODEN Mar. 1993 37 p
 (Contract NAS2-13285)
 (NASA-CR-192282; NAS 1.26:192282; TR-93-02) Avail: CASI HC A03/MF A01

A phase 2 research and development effort was conducted in area transonic, compressible, inviscid flows with an ultimate goal of numerically modeling complex flows inherent in advanced helicopter blade designs. The algorithms and methodologies therefore are classified as adaptive methods, which are error estimation techniques for approximating the local numerical error, and automatically refine or unrefine the mesh so as to deliver a given level of accuracy. The result is a scheme which attempts to produce the best possible results with the least number of grid points, degrees of freedom, and operations. These types of schemes automatically locate and resolve shocks, shear layers, and other flow details to an accuracy level specified by the user of the code. The phase 1 work involved a feasibility study of h-adaptive methods for steady viscous flows, with emphasis on accurate simulation of vortex initiation, migration, and interaction. Phase 2 effort focused on extending these algorithms and methodologies to a three-dimensional topology. Author

N93-20288 Oklahoma Univ., Norman.
COMPUTATIONAL ANALYSIS OF HYPERSONIC FLOWS PAST GENERALIZED CONE-DERIVED WAVERIDERS Ph.D. Thesis

XIAOHAI HE 1992 208 p
 Avail: Univ. Microfilms Order No. DA9238469

A comprehensive inviscid and viscous numerical simulation of hypersonic flow past non-conical rounded-nose waveriders is presented. A new set of parameters is introduced into the formulation of waverider configurations that provides a systematic way to generate waverider shapes in terms of various design considerations. The flow field and aerodynamic forces at off-design conditions are solved inviscidly by a space marching CFD code with the initial data plane provided by a time marching Navier-Stokes CFD code. The numerical method uses a flux difference splitting algorithm. A grid system generated by elliptic differential equations is developed, and its distribution near the sharp leading edge of a waverider is properly handled. Off-design conditions include off-design Mach numbers, angles of attack, and rounded leading edges. A wide range of waverider configurations, including waveriders with reflexed trailing edges and relatively thick waveriders with large leading-edge angles, is numerically investigated and compared. On-design viscous flows past a waverider with a sharp leading edge at $M_{\infty} = 4$ and at different Reynolds numbers and temperature boundary conditions are obtained by a time-marching Navier-Stokes solver on an off-site

IBM super computer. These calculations show the effects of viscous interactions which are influential near the leading edges.

Dissert. Abstr.

N93-20686# Academy of Sciences (USSR), Novosibirsk.
**ON THE DISTURBANCES DEVELOPMENT IN THE
 SUPERSONIC BOUNDARY LAYER**

S. A. GAPONOV /in Manitoba Univ., Proceedings of the Thirteenth Canadian Congress of Applied Mechanics p 456-457 May 1991 Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

The stability of the supersonic boundary layer on a flat plate is studied both for parallel and nonparallel flows. The Dunn-Lin equations were used in the first case and a theoretical approach is applied for the second one. A comparison of experimental data from the literature with the theoretical predictions show close agreement for $f = \arctg(\beta/\alpha(m))$ is less than 70 deg (where β is the wavenumber in the z direction and $\alpha(m)$ is the eigenvalue of the Dunn-Lin problem). Two reasons for the discrepancy at higher angles are offered: (1) the interaction of waves with close parameters in the nonparallel flow; and (2) nonlinear interaction of the waves. Author (CISTI)

N93-20806# Manchester Univ. (England). Aeronautical Engineering Group.

THE AERODYNAMIC PERFORMANCE OF LASER DRILLED SHEETS

D. I. A. POLL, M. DANKS, and B. E. HUMPHREYS (Aerospace Systems and Technologies, Stanley, England) 1992 6 p Sponsored by British Aerospace Regional Aircraft Ltd. and Commission of the European Communities (AERO-REPT-9204; ETN-93-93004) Avail: CASI HC A02/MF A01

The aerodynamic characteristics of laser drilled titanium sheets were investigated. In the context of laminar flow applications, the most important issues are the pressure drop across the surface for a given mass flow rate per unit area and the nominal hole diameter. In order to investigate these a simple flow model was developed for an ideal hole. This shows that the pressure drop is a quadratic function of the mass flow rate. Data for eight perforated sheets are presented in terms of the parameters contained within the model. Operating ranges for these parameters are identified. A method for the specification of suction surface geometry, which facilitates accurate manufacture and subsequent quality control, is proposed. ESA

N93-20807# Manchester Univ. (England). Aeronautical Engineering Group.

**THE EFFECT OF SURFACE SUCTION NEAR THE LEADING
 EDGE OF A SWEEP-BACK WING**

D. I. A. POLL, M. DANKS, and A. J. DAVIES (British Aerospace Regional Aircraft Ltd., Hatfield, England) 1992 8 p Sponsored by British Aerospace Regional Aircraft Ltd. and Commission of the European Communities (AERO-REPT-9205; ETN-93-93005) Avail: CASI HC A02/MF A01

The problem of boundary layer transition in the immediate vicinity of a swept leading edge was investigated. The geometry and associated Reynolds numbers were such that the tests were effectively super flight scale. Of specific interest were the issues of attachment line contamination and cross flow instability since these are known to be 'barrier' problems in the design of swept, laminar flow wings. Boundary layer suction was provided by means of laser drilled holes in a titanium surface. Preliminary results indicated that without suction, and with an uncontaminated attachment line flow, transition occurs through cross flow instability. When suction was used, cross flow transition could be effectively delayed by very low through surface velocities. Comparisons between the impervious surface data and the predictions of the linear stability theory $+e(\sup 9)$ model for transition were made. The agreement was found to be good for the attachment line flow but poor for cross flow. ESA

N93-21054# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Hubschrauber und Flugzeuge.

HEAT LOADS AS KEY PROBLEM OF HYPERSONIC FLIGHT

E. H. HIRSCHHEL 1 Jul. 1992 26 p Presented at Hermann-Oberth-Gesellschaft 40th Raumfahrtkongress, Gosen/Berlin, Germany, 6 Jun. 1991 Submitted for publication (MBB-FE-202-S-PUB-0486; ETN-93-93425) Avail: CASI HC A03/MF A01

Different heat load problems, that occur in the airframe during hypersonic flight, and their solutions are addressed. Surface radiation cooling is the key for external parts to drastically reduce heat loads. However, this makes necessary specific surface properties, especially a high radiation emissivity, small catalytic recombination effects, and depending on the material, an effective oxidation protection. The close coupling of aerothermodynamic and materials properties and the resulting prediction and simulation problems are discussed. Several examples are used for illustration purposes. ESA

N93-21059# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Military Aircraft Div.

**APPLICATION OF THE EULER METHOD EUFLEX TO A
 FIGHTER-TYPE AIRPLANE CONFIGURATION AT TRANSONIC
 SPEED**

STEFAN HEISS, ALBRECHT EBERLE, LUCIANO FORNASIER, and WOLFGANG PAUL Jun. 1992 23 p Presented at 10th AIAA Applied Aerodynamics Conference, Palo Alto, CA, 22-24 Jun. 1992 Previously announced in IAA as A92-45573 Sponsored by MBB (MBB-FE-211-S-PUB-0489-A; ETN-93-93430) Copyright Avail: CASI HC A03/MF A01

The application of the finite volume Euler method, EUFLEX, to an advanced fighter airplane configuration using an H type and monoblock grid topology is reported. Comparisons of the numerical results with wind tunnel data, both in terms of global aerodynamic coefficients and of wing surface pressures, are used to assess the capabilities of the present approach in the analysis of complex flow phenomena experienced by the aircraft throughout its flight envelope. Investigated phenomena include the following: flow nonlinearities induced by the highly swept delta wing at moderate to high angles of attack and by recompression shocks at transonic and supersonic speeds; and interference flows due to wing canard coupling, underwing pylon missile installation close to wing tip pod, and propulsion effects. Trailing edge flap deflection is simulated using a novel local grid topology. A description of the Euler solver is provided, and the interactive technique used to generate the numerical grid directly from the computer aided design model of the configuration is presented. Selected results for Mach numbers 0.60, 0.90, 1.20, and 1.30 are discussed. ESA

N93-21562*# George Washington Univ., Washington, DC. School of Engineering and Applied Science.

**PROGRAM OF RESEARCH IN FLIGHT DYNAMICS IN THE
 JIAFS AT NASA-LANGLEY RESEARCH CENTER Annual
 Status Report, 1 Dec. 1991 - 30 Nov. 1992**

30 Nov. 1992 6 p

(Contract NCC1-29)

(NASA-CR-191885; NAS 1.26:191885) Avail: CASI HC A02/MF A01

The program objectives are fully defined in the original proposal entitled 'Program of Research in Flight Dynamics in the Joint Institute for the Advancement of Flight Sciences (JIAFS) at NASA-Langley Research Center,' which was originated March 20, 1975 and in the renewal of the research program dated December 1, 1991. The program includes four major topics: (1) the improvement of existing methods and development of new methods for flight test data analysis; (2) the application of these methods to real flight test data obtained from advanced airplanes; (3) the correlation of flight results with wind tunnel measurements; and (4) the modeling, and control of aircraft, space structures, and spacecraft. Derived from text

N93-21659# European Space Agency, Paris (France).
ANALYTIC FORMULATION OF UNSTEADY PROFILE AERODYNAMICS AND ITS APPLICATION TO SIMULATION OF ROTORS [ANALYTISCHE FORMULIERUNG DER INSTATIONAEREN PROFILBEIWERTE UND DEREN ANWENDUNG IN DER ROTORSIMULATION]

BEREND VANDERWALL (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany.) Aug. 1992 172 p Transl. into ENGLISH of Analytische Formulierung der Instationaeren Profilbeiwerte und Deren Anwendung in der Rotorsimulation (Brunswick, Germany, DLR), Mar. 1990 117 p Original language document was announced as N91-13415 (ESA-TT-1244; DLR-FB-90-28; ETN-93-93080) Avail: CASI HC A08/MF A02; original German version available from DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

A new approach to the modeling of rotor aerodynamics is addressed. The steady state aerodynamic coefficients for an aerofoil section are described in terms of a set of analytical equations. The periodically varying velocities over the aerofoil section can then be converted into similarly periodic displacements of angle of attack and stall angle of attack. These can then be fed directly into the simulation. It is very important to have models of the blade dynamics and induced velocities of sufficient accuracy. For this reason a modal method is used to describe the blade dynamics and the induced velocities are modeled in terms of a rigid, distorted spiral geometry, developed from measurements. Results show that a good compromise was achieved between the requirements for short computation times and accuracy. This is of particular interest with respect to the calculation and design of higher harmonic control systems. ESA

N93-21761# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Abt. fuer Numerische Stroemungsmechanik.

AEROTHERMODYNAMIC PROPERTIES OF HYPERSONIC FLOWS OVER RADIATION-ADIABATIC SURFACES Ph.D. Thesis - Technische Univ. [AEROTHERMODYNAMISCHE EIGENSCHAFTEN VON HYPERSCHALLSTROEMUNGEN UEBER STRAHLUNGSADIABATE OBERFLAECHE]

STEFAN RIEDELBAUCH 18 Nov. 1991 131 p In GERMAN Original contains color illustrations (ISSN 0939-2963)

(DLR-FB-91-42; ETN-93-91931) Avail: CASI HC A07/MF A02; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

The aerothermodynamic properties of hypersonic flows over radiation adiabatic surfaces are investigated by the numerical simulation of the viscous flow field past a delta wing. The compressible Navier-Stokes equations are solved by an implicit nonfactorized finite difference algorithm with upwind discretization and TVD (Total Variation Diminishing) property. Laminar flow is assumed. The validation of the scheme with experimental and other numerical results is sketched. Algebraic methods are used for grid generation. A simple procedure of grid adaptation for the bow shock is described. The inviscid and viscous flow fields are analyzed in detail. Locally increased surface temperatures are caused by the attachment lines on the windward and the leeward side of the wing. The radiation-adiabatic surface temperature is compared with results obtained by approximate methods. The influence of the variation of characteristic flow parameters and length scales on the radiation adiabatic surface temperature is discussed. ESA

N93-21763# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Inst. fuer Experimentelle Stroemungsmechanik.

UNSTEADY NAVIER-STOKES METHOD FOR ACCELERATED MOVING AIRFOILS WITH SEPARATION [INSTATIONAERES NAVIER-STOKES-VERFAHREN FUER BESCHLEUNIGT BEWEGTE PROFILE MIT ABLOESUNG]

WOLFGANG GEISSLER 17 Jan. 1992 71 p In GERMAN (ISSN 0939-2963)

(DLR-FB-92-03; ETN-93-91933) Avail: CASI HC A04/MF A01; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

A method to calculate unsteady viscous flows with separation is presented. These flows are of increasing concern in different areas of application such as vortex separation (dynamic stall) on a retreating helicopter rotor blade or the buffeting problem for elastic wings at transonic flows. In many cases, these phenomena limit the flight envelope of the aircraft. Improved numerical methods based on the Reynolds averaged Navier-Stokes equations in connection with now available supercomputers enable a successful investigation of the complicated flows involved. The method is applied to problems of accelerated moving airfoils (harmonic ramp motion). Comparisons with available experimental data are discussed. ESA

N93-21766# Midwest Research Inst., Golden, CO.

COMBINED EXPERIMENT, PHASE 1

C. P. BUTTERFIELD, W. P. MUSIAL, and D. A. SIMMS Oct. 1992 220 p

(Contract DE-AC02-83CH-10093)

(DE93-000012; NREL/TP-257-4655-PHASE-1) Avail: CASI HC A10/MF A03

How does wind tunnel airfoil data differ from the airfoil performance on an operating horizontal axis wind turbine (HAWT)? The National Renewable Energy laboratory has been conducting a comprehensive test program focused on answering this question and understanding the basic fluid mechanics of rotating HAWT stall aerodynamics. The basic approach was to instrument a wind rotor, using an airfoil that was well documented by wind tunnel tests, and measure operating pressure distributions on the rotating blade. Based on the integrated values of the pressure data, airfoil performance coefficients were obtained, and comparisons were made between the rotating data and the wind tunnel data. Care was taken to note the aerodynamic and geometric differences between the rotating and the wind tunnel models. This is the first of two reports describing the Combined Experiment Program and its results. This Phase 1 report covers background information such as test setup and instrumentation. It also includes wind tunnel test results and roughness testing. DOE

N93-21796# Federal Aviation Administration, Cambridge, MA.
PROCEEDINGS OF THE AIRCRAFT WAKE VORTICES

CONFERENCE, VOLUME 1 Final Report

J. N. HALLOCK Jun. 1992 522 p Conference held at the Quality Hotel Capitol Hill, Washington, DC, 29-31 Oct. 1991 Sponsored by FAA, Washington, DC

(PB93-126449; DOT/VNTSC-FAA-92-7-VOL-1) Avail: CASI HC A22/MF A04

The volume contains the proceedings of the international conference of Aircraft Wake Vortices held at the Quality Hotel Capitol Hill, Washington, DC, on 29-31 Oct. 1991. The contributed papers discuss technological advances in the knowledge of the phenomenon, its effect on aircraft and airport capacity, detection techniques, and vortex avoidance schemes. GRA

N93-22015*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

SWEPT WING ATTACHMENT LINE CONTAMINATION FENCE Patent Application

BRUCE J. HOLMES, inventor (to NASA) 13 Dec. 1991 9 p (NASA-CASE-LAR-13400-1; NAS 1.71:LAR-13400-1; US-PATENT-APPL-SN-806066) Avail: CASI HC A02/MF A01

A device for controlling attachment line contamination on an airfoil is presented. A fence is installed on the leading edge of the airfoil in the freestream direction perpendicular to the airfoil, outboard of the fuselage boundary layer. The inboard side of the fence arrests the spanwise movement of the turbulent boundary layer while the laminar boundary layer on the outboard side of the fence eliminates any further turbulent contamination of the attachment line. NASA

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A93-24048**HUMAN FACTORS IN CRASHES OF COMMUTER AIRPLANES**

SUSAN P. BAKER (Johns Hopkins Univ., Baltimore, MD), MARGARET W. LAMB (Sunshine Aviation Safety Studies, Questa, NM), GUOHUA LI, and ROBERT S. DODD (Johns Hopkins Univ., Baltimore, MD) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 1 Jan. 1993 p. 63-68. refs (Contract DTFA01-90-C-00046; PHS-R49-CCR-302486-06)

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Pilots and frequent travelers on commuter aircraft are exposed to higher risks of death or injury than those on major air carriers. To provide a better understanding of the circumstances of crashes of scheduled commuter airplanes, National Transportation Safety Board data were analyzed for all cases of death, serious injury, or major damage involving commuter airplanes during 1983-88, when 172 people were killed and 207 injured in 118 events. Three-fourths of cases involved inadequate pilot performance, notably poor handling of emergencies and improper instrument flying procedures. Pilot errors occurred disproportionately in bad weather, which played a role in 30 percent of crashes. Aircraft malfunctions were involved in 42 percent of crashes. Certain airplanes were overinvolved in gear-up landings or in crashes due to fuel mismanagement. Greater priority should be given to applying known preventive measures to the problem of commuter crashes.

Author

A93-24239*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AIRCRAFT ICING PROBLEMS - AFTER 50 YEARS

PORTER J. PERKINS (Sverdrup Technology, Inc., Brook Park, OH) and WILLIAM J. RIEKE (NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0392) Copyright

With the possible exception of tailplane-ice hazards, understanding of aircraft icing processes and their performance penalties and hazards has not changed fundamentally in 40-50 years. A survey is presently conducted of the aircraft design criteria, ice-detection and deicing hardware, and flight procedures, that have been developed to cope with icing phenomena. Attention is given to pilot icing conditions flight-training requirements, which are essential for the recognition of icing situations requiring corrective action. O.C.

A93-24837#**FIELD STUDIES OF HOLD-OVER-TIMES FOR TYPE II ANTI-ICING FLUIDS - RESULTS AND INSIGHTS**

PETER P. POLOMSKI and MICHAEL R. MULLER (Rutgers Univ., Piscataway, NJ) Jan. 1993 9 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by FAA refs

(AIAA PAPER 93-0749) Copyright

In situ testing of deicing/anticing fluids intended to protect the flying public during frozen precipitation events by establishing holdover time guidelines is reviewed. Emphasis is placed on the analysis of the 1991-1992 data, the implications of the data, and recommendations for future work. It is noted that the most important variable is the determination of frosticator plate failure. Current test guidelines allow for failure criteria to be influenced entirely by the judgment of the operator based on visual insight which can be influenced by visibility, glare from indirect lighting, and individual bias. Standardization of failure must be based more on scientific principles to achieve scatter reduction. O.G.

A93-25125* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE FAA/NASA FLIGHT LOADS MONITORING PROGRAM - THE PROTOTYPE SYSTEM AND ITS BENEFITS FOR THE AVIATION COMMUNITY

JULIA H. WHITEHEAD, MITCHEL E. THOMAS (NASA, Langley Research Center, Hampton, VA), DAVID J. CARRELLI (Lockheed Engineering and Sciences Co., Hampton, VA), and NORMAN L. CRABILL (Eagle Engineering, Inc., Hampton, VA) SAFE Journal vol. 22, no. 6 Nov.-Dec. 1992 p. 20-24. refs

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The FAA established the flight load monitoring program to collect a data base of typical flight operational loads experienced by commercial transports. This system will provide a comprehensive monitoring of aircraft loading conditions with over 20 flight parameters being recorded simultaneously. NASA is designing and testing a prototype data collection and analysis system which will be implemented into an FAA operational program. This paper presents the program's objectives and the proposed development testing on a commercial Boeing 737-400. The prototype system, its data processing schemes, and reports are described. The searching criteria or flight attributes generated for each flight are listed. The data processing system will provide the aviation community with a powerful tool for the study of transport flight loading conditions and the system's flexibility will accommodate individual studies and specialized concerns. A.O.

A93-25249**REDUCING HELICOPTER OPERATING COSTS**

JOHN R. OLSON (Sikorsky Aircraft, Stratford, CT) Vertiflite (ISSN 0042-4455) vol. 39, no. 1 Jan.-Feb. 1993 p. 10-16.

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The high acquisition costs and high insurance rates associated with civil helicopter operations, in conjunction with high costs for maintenance and parts, low utilization, and the diseconomies of dispersed small scale operations, have conspired to make seat-mile costs of helicopter commuter service an order of magnitude higher than for turboprop fixed-wing aircraft of comparable passenger capacity and stage lengths. The present study attempts to identify plausible changes in helicopter design and operation that could bring down seat-mile costs to a factor of only four above turboprop costs. O.C.

A93-26423**AN INDUSTRY HELD HOSTAGE**

WILLIAM TRIPLETT Air & Space (ISSN 0886-2257) vol. 7, no. 6 Feb.-Mar. 1993 p. 26-38.

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In the wake of the terrorist bombing of Pan Am flight 301 over Lockerbie, Scotland, the President's Commission on Aviation Security and Terrorism found that 'The U.S. civil aviation security system is seriously flawed and has failed to provide the proper level of protection'; it documented flaws in all airline operations relating to terrorism, from security training procedures to explosives detection. The commission report also led to the creation of the Department of Transportation's Office of Intelligence and Security. The present survey of antiterrorist activities undertaken by U.S. airlines to date gives attention to cost-related security matters. O.C.

A93-27136**THE DEVELOPMENT OF AN ALTITUDE AWARENESS PROGRAM - AN INTEGRATED APPROACH**

THOMAS M. GRANDA (Carlow Associates, Inc., Fairfax, VA), DONALD H. MCCLURE (Air Line Pilots Association, Herndon, VA), and JAMES W. FOGARTY (USAir, Pittsburgh, PA) In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 47-51. refs

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The nature and rate of altitude deviations are briefly discussed. The development and implementation of the USAir Altitude Awareness Program, which was established to decrease the

number of altitude deviations at USAir, is presented. This paper primarily describes two aspects of USAir's Altitude Awareness Program. The first aspect involves the program's emphasis on the cockpit procedural changes instituted at USAir to lower the rate of altitude 'busts'. The second aspect concerns a study involving pilots which seeks to understand the nature of individual altitude deviation incidents and provide a basis for understanding the common human error components of altitude deviations in general. The emphasis in this paper is on showing the extent of the data collection effort and in presenting some preliminary results from that data collection effort. Author

A93-27168

SPATIAL ORIENTATION AND WAYFINDING IN AIRPORT PASSENGER TERMINALS - IMPLICATIONS FOR ENVIRONMENTAL DESIGN

ANTHONY D. ANDRE and JEFFERSON M. KOONCE (Illinois Univ., Urbana) *In* Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 561-565. Research supported by Transportation Research Board and FAA refs Copyright

Passengers and visitors of our nation's major airports often encounter problems of spatial orientation and wayfinding. The present study used a multiple method strategy to determine the sources of guidance information that passengers deem most important, how successful those sources are, and what design qualities facilitate or inhibit their effectiveness. The results are consistent with established theories of human navigation and spatial cognition, and are used to generate specific guidelines for effective redesign. Author

A93-27370

A STUDY ON THE MARGINAL ANALYSIS METHOD FOR THE AIRLINE YIELD MANAGEMENT

JIAN-CHENG GUAN (Beijing Univ. of Aeronautics and Astronautics, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 4 Nov. 1992 p. 270-276. Translation. Previously cited in issue 22, p. 3884, Accession no. A92-53018 refs Copyright

A93-27393

AVIATION SAFETY CAN BENEFIT FROM SIMULATION OF THE DISPERSION OF HAZARDOUS MATERIAL

J. A. PUDYKIEWICZ (Atmospheric Environment Service, Montreal, Canada) and O. M. TURPEINEN (International Civil Aviation Organization, Montreal, Canada) ICAO Journal (ISSN 0018-8778) vol. 47, no. 12 Dec. 1992 p. 9-11. Copyright

Forecasts of the atmospheric dispersion of radioactive or toxic materials, as well as volcanic ash, must address three issues: (1) the accurate description of the location, time-evolution, and form of the release; (2) simulation of the dispersion of the material using the appropriate tracer model; and (3) the acquisition of the meteorological information required for solving the tracer model equations. Attention is given to the simulated dispersion of radioactive debris from the Chernobyl reactor and of the Mount Redoubt volcanic ash cloud. O.C.

A93-27394

RECENT EXPERIMENT FOCUSES ON OPERATIONAL IMPACT OF JET STREAM FORECAST ERRORS

JOEL TENENBAUM (New York State Univ., Purchase) ICAO Journal (ISSN 0018-8778) vol. 47, no. 12 Dec. 1992 p. 12, 13. Copyright

An evaluation is made of the long-distance airliner operation costs associated with errors in jet stream forecasts. The data considered were derived from an average of about one sample per week of British Airways' London-to-Bangkok route during January-March 1990 and December 1989; in two cases, the forecast winds were weaker than the analysis, and too little fuel was carried by the aircraft. For the winter season as a whole,

there occurred a systematic excess of 666 kg of fuel per flight. The implications of this result for various geographical regions are discussed. O.C.

A93-28196

VOLCANIC CLOUDS [LES NUAGES VOLCANIQUES]

MICHEL REDDAN (Conseil Supérieur de la Météorologie, Paris, France) Navigation (Paris) (ISSN 0028-1530) vol. 41, no. 161 Jan. 1993 p. 63-67. In French.

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Incidents associated with the 1991 eruption of Mt. Pinatubo in the Philippines illustrate the considerable danger to commercial aviation posed by clouds of volcanic ash. Accounts are presently given of the electrification phenomena associated with such clouds, their effects on turbofan blades, combustors, and turbines, and procedures for the swift and safe exit from such clouds when they are encountered without warning. O.C.

A93-28481

ALTERNATIVE APPROACH ROUTES TO RWY 24 AT OSLO AIRPORT, FORNEBU

HANS E. BOHN (Civil Aviation Administration, Oslo, Norway) and KNUT FUGLUM (Asplan Ostlandet, Sandvika, Norway) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 191-194.

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A summary of a study conducted by the Civil Aviation Administration of Norway to find alternatives to the ILS system approach to runway 24 at Oslo Airport, Fornebu, is presented. Some alternatives showed very encouraging figures with respect to the number of people living in the noise zones. However, all of them had serious disadvantages, such as loss of capacity and regularity. C.A.B.

A93-29431

FLIGHT SAFETY IN A PERTURBED ATMOSPHERE [BEZOPASNOST' POLETOV V VOZMUSHCHENNOI ATMOSFERE]

GENNADII A. FILATOV, GALINA S. PUMINOVA, and PAVEL V. SIL'VESTROV (Moscow Izdatel'stvo Transport 1992 272 p. In Russian. refs (ISBN 5-277-00815-2) Copyright

The characteristics of aircraft dynamics associated with perturbed air flow are examined. Particular attention is given to the effect of strong atmospheric turbulence, wind shear, and trailing vortices on the flight. Flight accidents resulting from special flight conditions are analyzed. Recommendations are given concerning the avoidance of the effects of atmospheric turbulence during take-off and landing. V.L.

A93-29442

AN OVERVIEW ON PRACTICAL APPLICATION OF HELICOPTER NOISE CERTIFICATION RULES

ESTIVAL and F. D'AMBRA (Aerospatiale, Div. Helicopteres, Paris, France) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 6 p. Copyright

A development history and current development status overview are presented for French efforts toward the improvement of manufacturers' noise certification methods for helicopters. The average margins from ICAO noise limits have been increased by more than 6 dB over the last 30 years, for the three specified flight procedures (flyover, takeoff, and approach). Attention is given to prospective improvements in test procedures and future trends in helicopter noise performance. O.C.

N93-19590*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS: FOURTH COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 1

DAN D. VICROY, comp., ROLAND L. BOWLES, comp., and ROBERT H. PASSMAN, comp. (Federal Aviation Administration, Washington, DC.) Sep. 1992 597 p Conference held in Williamsburg, VA, 14-16 Apr. 1992; sponsored by NASA and FAA Original contains color illustrations

(Contract RTOP 505-64-12-01)

(NASA-CP-10105-PT-1; NAS 1.55:10105-PT-1;

DOT/FAA/RD-92/19-I-PT-1) Avail: CASI HC A25/MF A06; 28 functional color pages

The purpose of the meeting was to transfer significant ongoing results of the NASA/FAA joint Airborne Wind Shear Program to the technical industry and to pose problems of current concern to the combined group. It also provided a forum for manufacturers to review forward-look technology concepts and for technologists to gain an understanding of the problems encountered by the manufacturers during the development of airborne equipment and the FAA certification requirements. The present document was compiled to record the essence of the technology updates and discussions which follow each.

N93-19591*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PROGRAM OVERVIEW: 1991 FLIGHT TEST OBJECTIVES

ROLAND L. BOWLES *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 7-22 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: the Joint NASA/FAA Airborne Wind Shear Detection and Avoidance Program; the windshear problem; NASA/FAA Wind Shear Program objectives; program elements; Wind Shear Program roadmap; airborne wind shear sensors; 1991 wind shear flight experiments; operative wind shear detection systems; research aircraft sensor installations; and 1991 test results. Author

N93-19592*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FLIGHT TEST OPERATIONS

MICHAEL S. LEWIS *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 23-43 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

Flight test operations concerning the Joint NASA/FAA Airborne Wind Shear Detection and Avoidance Program 1991 Flight Experiments are presented in viewgraph form and include the following: research aircraft sensor installations; wind shear reactive sensor operation; wind shear IR sensor operation; wind shear radar sensor operation; wind shear lidar sensor operation; and 1991 flight test summary. Author

N93-19593*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NASA WIND SHEAR FLIGHT TEST IN SITU RESULTS

ROSA M. OSEGUERA *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 45-58 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

The main objectives in developing the NASA in situ windshear detection algorithm were to provide a measurement standard for validation of forward-look sensors under development, and to demonstrate the algorithm's ability to operate with a suitably low nuisance alert rate. It was necessary to know exactly how the algorithm was implemented and what parameters and filtering were used, in order to be able to fully test its effectiveness and correlate in situ results with forward-look sensor data. Author

N93-19594*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AIR/GROUND WIND SHEAR INFORMATION INTEGRATION: FLIGHT TEST RESULTS

DAVID A. HINTON *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 59-114 Sep. 1992 Original contains color illustrations

Avail: CASI HC A04/MF A06; 28 functional color pages

An element of the NASA/FAA wind shear program is the integration of ground-based microburst information on the flight deck, to support airborne wind shear alerting and microburst avoidance. NASA conducted a wind shear flight test program in the summer of 1991 during which airborne processing of Terminal Doppler Weather Radar (TDWR) data was used to derive microburst alerts. High level microburst products were extracted from TDWR, transmitted to a NASA Boeing 737 in flight via data link, and processed to estimate the wind shear hazard level (F-factor) that would be experienced by the aircraft in the core of each microburst. The microburst location and F-factor were used to derive a situation display and alerts. The situation display was successfully used to maneuver the aircraft for microburst penetrations, during which in situ 'truth' measurements were made. A total of 19 penetrations were made of TDWR-reported microburst locations, resulting in 18 airborne microburst alerts from the TDWR data and two microburst alerts from the airborne in situ measurements. The primary factors affecting alerting performance were spatial offset of the flight path from the region of strongest shear, differences in TDWR measurement altitude and airplane penetration altitude, and variations in microburst outflow profiles. Predicted and measured F-factors agreed well in penetrations near microburst cores. Although improvements in airborne and ground processing of the TDWR measurement would be required to support an airborne executive-level alerting protocol, the feasibility of airborne utilization of TDWR data link data has been demonstrated. Author

N93-19595*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DOPPLER RADAR RESULTS

EMEDIO M. BRACALENTE *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 115-140 Sep. 1992 Original contains color illustrations

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are covered in viewgraph form and include the following: (1) a summary of radar flight data collected; (2) a video of combined aft cockpit, nose camera, and radar hazard displays; (3) a comparison of airborne radar F-factor measurements with in situ and Terminal Doppler Weather Radar (TDWR) F-factors for some sample events; and (4) a summary of wind shear detection performance. Author

N93-19597*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

WIND SHEAR HAZARD DETERMINATION

MICHAEL S. LEWIS *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 195-211 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: F-factor relationship with aircraft performance; F-factor formulations; the F-bar index; F-factor hazard limit; F-bar with Doppler sensors; and F-bar profile composite. Author

N93-19598*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THREE-DIMENSIONAL NUMERICAL SIMULATION OF THE 20 JUNE 1991, ORLANDO MICROBURST

FRED H. PROCTOR *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 213-243 Sep. 1992 Original

contains color illustrations

Avail: CASI HC A03/MF A06; 28 functional color pages

On 20 June 1991, NASA's Boeing 737, equipped with in-situ and look-ahead wind-shear detection systems, made direct low-level penetrations (300-350 m AGL) through a microburst during several stages of its evolution. This microburst was located roughly 20 km northeast of Orlando International Airport and was monitored by a Terminal Doppler Weather Radar (TDWR) located about 10 km south of the airport. The first NASA encounter with this microburst (Event 142), at approximately 2041 UTC, was during its intensification phase. At flight level, in-situ measurements indicated a peak 1-km (averaged) F-factor of approximately 0.1. The second NASA encounter (Event 143) occurred at approximately 2046 UTC, about the time of microburst peak intensity. It was during this penetration that a peak 1-km F-factor of approximately 17 was encountered, which was the largest in-situ measurement of the 1991 summer deployment. By the third encounter (Event 144), at approximately 2051 UTC, the microburst had expanded into a macroburst. During this phase of evolution, an in-situ 1-km F-factor of 0.08 was measured. The focus of this paper is to examine this microburst via numerical simulation from an unsteady, three-dimensional meteorological cloud model. The simulated high-resolution data fields of wind, temperature, radar reflectivity factor, and precipitation are closely examined so as to derive information not readily available from 'observations' and to enhance our understanding of the actual event. Characteristics of the simulated microburst evolution are compared with TDWR and in-situ measurements.

Author

N93-19600*# Martin Marietta Aerospace, Washington, DC. Air Traffic Systems.

AN APPROACH TO EVALUATING REACTIVE AIRBORNE WIND SHEAR SYSTEMS

JOSEPH P. GIBSON, JR. *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 287-301 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

An approach to evaluating reactive airborne windshear detection systems was developed to support a deployment study for future FAA ground-based windshear detection systems. The deployment study methodology assesses potential future safety enhancements beyond planned capabilities. The reactive airborne systems will be an integral part of planned windshear safety enhancements. The approach to evaluating reactive airborne systems involves separate analyses for both landing and take-off scenario. The analysis estimates the probability of effective warning considering several factors including NASA energy height loss characteristics, reactive alert timing, and a probability distribution for microburst strength.

Author

N93-19601*# Allied-Signal Aerospace Co., Fort Lauderdale, FL. **RDR-4B DOPPLER WEATHER RADAR WITH FORWARD LOOKING WIND SHEAR DETECTION CAPABILITY**

STEVEN S. GRASLEY *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 317-338 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: Bendix/King atmospheric transport and dispersion (ATAD) position; RDR-4A technical baseline; RTA-4A characteristics; RDR-4 antenna characteristics; modification of RDR-4A to RDR-4B; RDR-4A functional block diagram; RDR-4B characteristics; development/test plan; CV-580 testing capability; CV-580 test results; Continental A300 test configuration; Continental Data Recording Program operational considerations; Continental A300 test results; and display considerations.

Author

N93-19602*# Rockwell International Corp., Cedar Rapids, IA. Air Transport Div.

AIRBORNE DOPPLER RADAR RESEARCH AT ROCKWELL INTERNATIONAL

ROY E. ROBERTSON *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 339-371 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: the Collins 1991 Windshear Flight Program; and system considerations.

Author

N93-19603*# Westinghouse Electric Corp., Baltimore, MD. Electronic Systems Group.

ACQUISITION AND USE OF ORLANDO, FLORIDA AND CONTINENTAL AIRBUS RADAR FLIGHT TEST DATA

MICHAEL C. EIDE and BRUCE MATHEWS *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 373-388 Sep. 1992

Avail: CASI HC A03/MF A06; 28 functional color pages

Westinghouse is developing a lookdown pulse Doppler radar for production as the sensor and processor of a forward looking hazardous windshear detection and avoidance system. A data collection prototype of that product was ready for flight testing in Orlando to encounter low level windshear in corroboration with the FAA-Terminal Doppler Weather Radar (TDWR). Airborne real-time processing and display of the hazard factor were demonstrated with TDWR facilitated intercepts and penetrations of over 80 microbursts in a three day period, including microbursts with hazard factors in excess of .16 (with 500 ft. PIREP altitude loss) and the hazard factor display at 6 n.mi. of a visually transparent ('dry') microburst with TDWR corroborated outflow reflectivities of +5 dBz. Range gated Doppler spectrum data was recorded for subsequent development and refinement of hazard factor detection and urban clutter rejection algorithms. Following Orlando, the data collection radar was supplemental type certified for in revenue service on a Continental Airlines Airbus in an automatic and non-interfering basis with its ARINC 708 radar to allow Westinghouse to confirm its understanding of commercial aircraft installation, interface realities, and urban airport clutter. A number of software upgrades, all of which were verified at the Receiver-Transmitter-Processor (RTP) hardware bench with Orlando microburst data to produce desired advanced warning hazard factor detection, included some preliminary loads with automatic (sliding window average hazard factor) detection and annunciation recording. The current (14-APR-92) configured software is free from false and/or nuisance alerts (CAUTIONS, WARNINGS, etc.) for all take-off and landing approaches, under 2500 ft. altitude to weight-on-wheels, into all encountered airports, including Newark (NJ), LAX, Denver, Houston, Cleveland, etc. Using the Orlando data collected on hazardous microbursts, Westinghouse has developed a lookdown pulse Doppler radar product with signal and data processing algorithms which detect realistic microburst hazards and has demonstrated those algorithms produce no false alerts (or nuisance alerts) in urban airport ground moving vehicle (GMTI) and/or clutter environments.

Author

N93-19604*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

VERTICAL WIND ESTIMATION FROM HORIZONTAL WIND MEASUREMENTS

DAN D. VICROY *In* its Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 391-416 Sep. 1992 Original contains color illustrations

Avail: CASI HC A03/MF A06; 28 functional color pages

This presentation begins with a brief description of the downdraft measurement problem for airborne Doppler based systems and the importance of the downdraft in assessing the hazard posed by a microburst wind shear. This is followed by a review of research on the feasibility of using simple microburst models to compute the downdraft from horizontal wind measurements. The current methodologies for computing the vertical wind are then discussed. A summary of the results and the plan for future research are also presented.

Author

N93-19605*# Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.

MICROBURST CHARACTERISTICS DETERMINED FROM 1988-1991 TDWR TESTBED MEASUREMENTS

PAUL J. BIRON and MARK A. ISAMINGER *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 417-455 Sep. 1992
 Avail: CASI HC A03/MF A06; 28 functional color pages

This paper presents some recent results germane to airborne windshear system design and certification. We first discuss the data analysis procedure and the associated caveats. The relative frequency, severity, and duration of microburst hazards at the various locations is important for determining the tradeoffs between safety and operational impact of false alerts which are encompassed in detection system thresholds. We then consider radar/lidar design issues such as reflective in microbursts and the vertical structure of outflows. Finally, we provide recent surface thermodynamic data associated with microbursts. Author

N93-19608*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

GROUND CLUTTER MEASUREMENTS USING THE NASA AIRBORNE DOPPLER RADAR: DESCRIPTION OF CLUTTER AT THE DENVER AND PHILADELPHIA AIRPORTS

STEVEN D. HARRAH, VICTOR E. DELNORE (Lockheed Engineering and Sciences Co., Hampton, VA.), MICHAEL S. GOODRICH (Lockheed Engineering and Sciences Co., Hampton, VA.), and CHRIS VONHAGEL *In* its Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 499-516 Sep. 1992
 Avail: CASI HC A03/MF A06; 28 functional color pages

Detection of hazardous wind shears from an airborne platform, using commercial sized radar hardware, has been debated and researched for several years. The primary concern has been the requirement for 'look-down' capability in a Doppler radar during the approach and landing phases of flight. During 'look-down' operation, the received signal (weather signature) will be corrupted by ground clutter returns. Ground clutter at and around urban airports can have large values of Normalized Radar Cross Section (NRCS) producing clutter returns which could saturate the radar's receiver, thus disabling the radar entirely, or at least from its intended function. The purpose of this research was to investigate the NRCS levels in an airport environment (scene), and to characterize the NRCS distribution across a variety of radar parameters. These results are also compared to results of a similar study using Synthetic Aperture Radar (SAR) images of the same scenes. This was necessary in order to quantify and characterize the differences and similarities between results derived from the real-aperture system flown on the NASA 737 aircraft and parametric studies which have previously been performed using the NASA airborne radar simulation program. Author

N93-19610*# Research Triangle Inst., Hampton, VA. **COMPARISON OF SIMULATED AND ACTUAL WIND SHEAR RADAR DATA PRODUCTS**

CHARLES L. BRITT and LUCILLE H. CRITTENDEN *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 541-560 Sep. 1992 Original contains color illustrations
 Avail: CASI HC A03/MF A06; 28 functional color pages

Prior to the development of the NASA experimental wind shear radar system, extensive computer simulations were conducted to determine the performance of the radar in combined weather and ground clutter environments. The simulation of the radar used analytical microburst models to determine weather returns and synthetic aperture radar (SAR) maps to determine ground clutter returns. These simulations were used to guide the development of hazard detection algorithms and to predict their performance. The structure of the radar simulation is reviewed. Actual flight data results from the Orlando and Denver tests are compared

with simulated results. Areas of agreement and disagreement of actual and simulated results are shown. Author

N93-19611*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NASA AIRBORNE RADAR WIND SHEAR DETECTION ALGORITHM AND THE DETECTION OF WET MICROBURSTS IN THE VICINITY OF ORLANDO, FLORIDA

CHARLES L. BRITT (Research Triangle Inst., Hampton, VA.) and EMEDIO M. BRACALENTE *In* its Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference Part 1 p 561-586 Sep. 1992
 Avail: CASI HC A03/MF A06; 28 functional color pages

The algorithms used in the NASA experimental wind shear radar system for detection, characterization, and determination of windshear hazard are discussed. The performance of the algorithms in the detection of wet microbursts near Orlando is presented. Various suggested algorithms that are currently being evaluated using the flight test results from Denver and Orlando are reviewed. Author

N93-19612*# Clemson Univ., SC. Dept. of Electrical and Computer Engineering.

SIGNAL PROCESSING FOR AIRBORNE DOPPLER RADAR DETECTION OF HAZARDOUS WIND SHEAR AS APPLIED TO NASA 1991 RADAR FLIGHT EXPERIMENT DATA

ERNEST G. BAXA, JR. *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 p 587-613 Sep. 1992
 Avail: CASI HC A03/MF A06; 28 functional color pages

Radar data collected during the 1991 NASA flight tests have been selectively analyzed to support research directed at developing both improved as well as new algorithms for detecting hazardous low-altitude windshear. Analysis of aircraft attitude data from several flights indicated that platform stability bandwidths were small compared to the data rate bandwidths which should support an assumption that radar returns can be treated as short time stationary. Various approaches at detection of weather returns in the presence of ground clutter are being investigated. Non-conventional clutter rejection through spectrum mode tracking and classification algorithms is a subject of continuing research. Based upon autoregressive modeling of the radar return time sequence, this approach may offer an alternative to overcome errors in conventional pulse-pair estimates. Adaptive filtering is being evaluated as a means of rejecting clutter with emphasis on low signal-to-clutter ratio situations, particularly in the presence of discrete clutter interference. An analysis of out-of-range clutter returns is included to illustrate effects of ground clutter interference due to range aliasing for aircraft on final approach. Data are presented to indicate how aircraft groundspeed might be corrected from the radar data as well as point to an observed problem of groundspeed estimate bias variation with radar antenna scan angle. A description of how recorded clutter return data are mixed with simulated weather returns is included. This enables the researcher to run controlled experiments to test signal processing algorithms. In the summary research efforts involving improved modelling of radar ground clutter returns and a Bayesian approach at hazard factor estimation are mentioned. Author

N93-19653# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.

AIRCRAFT ACCIDENTS: TRENDS IN AEROSPACE MEDICAL INVESTIGATION TECHNIQUES [LES ACCIDENTS D'AERONEFS: LES TENDANCES EN TECHNIQUES D'INVESTIGATION MEDICALE]

Sep. 1992 452 p *In* ENGLISH and FRENCH Symposium held in Cesme, Turkey, 27 Apr. - 1 May 1992 (AGARD-CP-532; ISBN-92-835-0687-1) Copyright Avail: CASI HC A20/MF A04

These proceedings include the Technical Evaluation Report and 58 papers of the Symposium sponsored by the AGARD

Aerospace Medical Panel held at the Altin Yunus Hotel, Cesme, Turkey, April 27 - May 1, 1992. Since the commencement of aviation, accidents have occurred for a variety of reasons in both fixed- and rotary-wing aircraft. As the complexity of aviation systems increased, so did the task of investigating aircraft accidents. At the same time, advanced techniques in aviation and weapon systems have exacerbated greatly the physiological and cognitive demands on aircrews. The result is that aircraft accidents due to material causes have diminished progressively while the percentage of human factor-caused accidents has not.

N93-19655# Swedish Air Force, Stockholm.

HOW DO WE INVESTIGATE THE HUMAN FACTOR IN AIRCRAFT ACCIDENTS?

KRISTINA POLLACK *In* AGARD, *Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques* 3 p Sep. 1992
Copyright Avail: CASI HC A01/MF A04

Today, the reality is that two-thirds of accidents and incidents are related to Human Factors. The concept of Human Factors is hard to define, identify or verify and definitions of the concept are as many as its advocates. In order to be aware of the complexity of the Human Factor in defining the root cause of an accident, to sub-categorize the concept, to be able to analyze and to see the trends over a period of time, trained experts are required. The findings, including the Human Factor findings, must influence the total report, which will form the basis of future flight safety work.

I.I.C.

N93-19656# Norton AFB Ballistic Missile Office, CA.

A METHOD FOR INVESTIGATING HUMAN FACTOR ASPECTS OF MILITARY AIRCRAFT ACCIDENTS

RICHARD A. LEVY *In* AGARD, *Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques* 19 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

The term 'human factor' denotes the relationship between the aviator, the aircraft and the environment. This covers a very large and complex interrelated panorama of factors, to include as an example, personal stress, training, physiology, aircraft flight characteristics, judgement and decision making, experience, nutrition, fatigue, and motivation. A major concern in assessing the significance of any particular human factor, or combination of factors, is the method employed in the collection of the raw data and subsequent analysis. The method of investigation and analysis employed by the U.S. Air Force, the problems inherent in this approach, and a joint, NATO human factors aircraft accident investigation methodology and program are discussed.

I.I.C.

N93-19657# Canadian Forces Headquarters, Ottawa (Ontario).
THE HUMAN FACTOR PROBLEM IN THE CANADIAN FORCES AVIATION

J. F. DAVID *In* AGARD, *Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques* 9 p Sep. 1992
Copyright Avail: CASI HC A02/MF A04

A 10-year analysis of human factor errors in the Canadian Air Force and where efforts should be concentrated to reduce human error are discussed. A 10-year analysis of our ground accidents and interestingly, close to 84 percent of the causes were related to personnel errors. Although the overall supervisory error was approximately 10 percent, it represented only 6 percent of the personnel error in air occurrences and close to 19 percent in ground occurrences. It was concluded that aviation psychology needs more investment. Furthermore, we cannot progress effectively in this area unless an extensive human factor data base is developed over coming decades. A human factor data base will allow for meaningful and more objective assessment by the decision makers and leaders.

I.I.C.

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UNDERLYING CAUSES OF ACCIDENTS: CASUAL NETWORKS

FERDINAND H. J. I. RAMECKERS *In* AGARD, *Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques* 4 p Sep. 1992

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This paper describes recent thinking about Accident Causation Theory, accident investigation and accident prevention. The central notion is that human error as the primary cause of accident causation, prevails at all levels in any complex organization and that accidents are caused by a unique network of factors, generated not only by unsafe acts of front-line operators, but also by fallible management decisions and all kinds of (psychological) preconditions that exist in the operations environment. New approaches aiming at possibilities of proactive prevention are briefly touched.

Author

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AID IN INVESTIGATION BY FIGURE ANIMATION [AIDE A L'ENQUETE PAR FIGURATION ANIMEE]

JEAN COUREAU *In* AGARD, *Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques* 11 p Sep. 1992
In FRENCH

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The investigation into the causes of accidents is an increasingly difficult undertaking because the human factors become largely prevalent in more than 75 percent of cases and everyone knows that they are delicate to interpret. Moreover the hardware is more and more comprised of electronics and software, so that the physical traces are often non-existent, outside of the parameters recorded on the 'crash recorder' and CVR. At the time of the analysis of the listings or layouts, the independent or little correlated parameters are interpreted easily, such as the driving mode and temperature. On the other hand, the quickly evolving and highly correlated parameters are harder to approach: the response of an aircraft to longitudinal and transverse stresses combined, for example. Software allowing the presentation on a graphic console of the parameters recorded from the pilot's viewpoint and animated in real time has been developed on the basis of a test by Dassault Aviation in Istres. The result satisfies all hopes: it is possible to view the flight at normal speed, at idle, accelerated, or to stop an image. The instrument panel is similar to that of the aircraft, the lever and the handle move as in reality. The horizon of the landscapes gives paravirtual information of the movements of the aircraft. The investigators really 'feel' the way in which the pilot reacted to the movements of the aircraft or the events which occurred: signs of carelessness, nervousness or even a change of pilot at the controls on a two-seater. In another presentation, a model seen from the outside reproduces the movements of the aircraft for complex trend analysis: spins, stalls, etc. Finally layouts, with or without zoom, give the evolution of the desired parameters in analog, as on paper, but with more flexibility of use. A video film presenting some typical flight cases is intended to emphasize the advantages of this kind of animation. A description of the operations of data acquisition of a military aircraft is given. A flow chart of the software for presentation on a graphic console is provided.

Author

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737-400 AT KEGWORTH, 8 JANUARY 1989: THE AAIB INVESTIGATION

R. D. G. CARTER *In* AGARD, *Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques* 15 p Sep. 1992
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A Boeing 737-400, jet transport aircraft, G-OBME, carrying 8 crew and 118 passengers, crashed near Kegworth, Leicestershire, on 8th January 1989. Of the 126 occupants, 47 died as a result of the accident and a further 74 suffered serious injury. This paper describes the structures and survivability investigations conducted into this accident by the Air Accidents Investigation Branch (AAIB) of the UK Department of Transport and reproduces the 11 AAIB Safety Recommendations (out of a total of 31 in the final report) concerning crashworthiness and survivability. This paper also describes the study performed for this investigation by the Cranfield Impact Centre, using the KRASH computer code to quantify impact pulses. The results of the KRASH work supported the AAIB recommendations in the G-OBME report and form the background

to a program at the Cranfield Impact Centre to facilitate the use of impact computer codes in aircraft accident investigations.

Author

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HUMAN FACTORS CAUSES AND MANAGEMENT STRATEGIES IN US AIR FORCE F-16 MISHAPS 1984-PRESENT

R. D. VANDERBEEK *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 5 p Sep. 1992

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The F-16 was introduced into the US Air Force in 1975 as the YF-16. It began significant operational employment in the early 1980's. For this paper statistics reflect mishaps since 1984, an arbitrary starting point reflecting mature operational F-16 employment as the venerable F-4 was being phased into retirement. A review of all F-16 Class 'A' mishaps (i.e. loss of aircraft, life, or damage exceeding \$1 million) from January 1984 through the end of March 1992 is presented. These mishaps are first listed within traditional causal categories. The mishaps where operator factor was cited are then recategorized into an expanded umbrella framework reflecting operationally meaningful subsets of situational awareness (SA). This SA framework more clearly demonstrates the role and importance of pilot attention and broader awareness in mishap avoidance. A program developed by Tactical Air Command, United States Air Force, to improve pilot attention and awareness is then discussed.

Author

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F-16 ACCIDENTS: THE NORWEGIAN EXPERIENCE

SUZANNE KLAIVENESS and HARALD T. ANDERSEN *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 3 p Sep. 1992

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Investigation reports from F-16 mishaps in the Royal Norwegian Air Force have been studied. In order to evaluate and improve the human factor information contained in the written records of F-16 mishaps, we have examined all information available in the Royal Norwegian Air Force for a ten year period, 1981 to 1990.

Author

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CATEGORY A F-16 ACCIDENTS IN THE BELGIAN AIR FORCE [LES ACCIDENTS F-16 DE CATEGORIE A A LA FORCE AERIENNE BELGE]

R. DELHAYE and P. VANDENBOSCH *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 3 p Sep. 1992 *In* FRENCH

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The Belgian Air Forces have been flying on F-16's since 1979; a review of all the class A mishaps is realized. This global study points out a particular human factor that could not be found in a single analysis of each mishap.

Author

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AIR ACCIDENTS IN THE FRENCH AIR FORCE [ACCIDENTS AERIENS DANS L'ARMEE DE L'AIR FRANCAISE (1977-1990): INFLUENCE DES AERONEFS DE LA NOUVELLE GENERATION]

G. OSSARD, H. MAROTTE, J. M. CLERE, and J. Y. GRAU *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 10 p Sep. 1992 *In* FRENCH

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This assessment of the air accidents in the French Air Force covered the period 1977-1990. During this period, combat aircraft of the new generation were brought into service without an important variation of the number of air accidents being observed, although the rate of accidents per 10,000 hours of flight appears higher for new aircraft. The human factor remains the main cause of the air accidents in the combat category, but seems to be implied with less frequency with aircraft of the new generation.

Mortality during combat accidents has tended to decrease regularly since 1987.

Author

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COMBAT AND TRAINING AIRCRAFT CLASS A MISHAPS IN THE BELGIAN AIR FORCE 1970-1990

I. BIESEMANS and P. VANDENBOSCH *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 12 p Sep. 1992

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The authors reviewed the files of 114 combat and training aircraft class A mishaps in the Belgian Air Force during the period from 1970-1990 with the cooperation of the office of the 'Belgian Accident Investigation Board'. They searched for the causes of these accidents i.e. Operational related, Logistics related and environmental factors, as well as contributory factors which played a role in these mishaps. While considering the causes of these accidents, they found that 71 percent were operational related, 22 percent logistics related and 7 percent were caused by environmental factors, such as birdstrike, foreign object damage (FOD) to the engine and unknown. From the 23 training aircraft lost, only one single aircraft crash was caused by a technical failure. The overall attrition rate for the period was 1.08/10,000 Aircraft Hours (A/C) hours, being 1.43/10,000 for combat A/C and 0.55/10,000 for training A/C. The introduction of the agile F-16 fighter in the early 1980's, coinciding with a serious decrease of the annual flying time and an undermanning in terms of experienced pilots in the squadrons was most probably responsible for the negative trend in the evolution of the annual attrition rate until 1989. Although the Belgian Air Force remained two years without a major accident, it must resolutely continue its effort in the field of accident prevention. By extending the time spent by aircrews in an operational squadron, supervised by experienced pilots, the Belgian Air Force should be able to reduce class A mishaps in the future.

Author

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UNDERLYING CAUSES OF HUMAN ERROR IN US ARMY ROTARY WIND ACCIDENTS

DANIEL T. FITZPATRICK *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 6 p Sep. 1992

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Human error has been a causal factor in 80 percent of U.S. Army aviation accidents. The focus of an accident investigation is to identify the task errors and related system inadequacies that contributed to the accident occurrence. Within the U.S. Army, crew error aviation accidents have been attributed to one of five reasons: individual failure (41 percent), leader failure (27 percent), standards failure (15 percent), training failure (12 percent), or other failure (5 percent). This study describes the most frequently occurring aircrew task errors and associated problem areas causing U.S. Army rotary wing accidents from FY-84 through FY-91. A total of 554 accidents occurred, resulting from 906 aircrew errors. The three most frequently occurring task errors involved improper decision, improper attention, and inadequate communication. Together, they accounted for one half of the total number of identified errors. The most frequently reported problem areas were inadequate crew coordination and improper scanning, which accounted for almost 40 percent of the errors. There were minor differences noted for problem areas based on aircraft type, time of occurrence, and responsible aircrew member. The U.S. Army Aviation Center has introduced corrective measures that address these problem areas. If successful, these corrective measures should reduce crew error, resulting in fewer accidents and a savings in personnel and equipment.

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ROYAL NAVAL HELICOPTER DITCHING EXPERIENCE

A. P. STEELE-PERKINS, R. P. JOHNSTON (Royal Naval Air Medical School, Hillhead, England), and P. BARTON (Royal Naval Air Medical School, Hillhead, England) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques

6 p Sep. 1992

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Controlled or uncontrolled water entry (ditching) by Royal Naval helicopters continues to occur and is a significant loss of resource - both human and aircraft. Accidents over a ten year period (1982-1991) are listed, causation and trends analyzed, and preventative measures put forward, as are initiatives to increase post ditching survivability. Author

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CANADIAN FORCES HELICOPTER DITCHINGS: 1952-1990

C. J. BROOKS *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 12 p Sep. 1992

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In 1982, Brooks and Rowe completed a 20 year retrospective review of the survival of all Canadian Military aircrew from ditching, parachuting or ejecting into both fresh and sea water, including the penetration of ice on frozen rivers and lakes. For the purpose of that study, all of these mishaps were classified as water accidents. The authors originally had intended to examine all water accidents back to 1952, but due to integration of the services and coincidental amalgamation of the RCAF Institute of Aviation Medicine and the Defence and Civil Institute of Environmental Medicine data prior to 1962 appeared to have been lost or destroyed. This paper summarizes the Canadian Military experience with ditching helicopters into water over the last 38 years. I.I.C.

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HELICOPTER ACCIDENTS OVER WATER IN THE NATIONAL NAVY: EPIDEMIOLOGICAL STUDY OVER THE PERIOD 1980-1991 [ACCIDENTS D'HELICOPTERE AU DESSUS DE L'EAU DANS LA MARINE NATIONALE: ETUDE EPIDEMIOLOGIQUE SUR LA PERIODE 1980-1991]

PIERRE GIRY, PIERRE COURCOUX (Conseil Permanent de la Securite Aerienn de la Marine, Paris, France), and JEAN PIERRE TAILLEMITE (Aeronautique Navale, Toulon-Naval, France) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 8 p Sep. 1992 *In* FRENCH

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During the years 1980-1991, 11 French Navy helicopters ditched in the sea: 3 Super-Frelon, 3 LYNX-WG13, 3 Alouette 3, and 2 Alouette 2, 10 of them being equipped with flottability devices. Structure default was the identified cause of the accident in 2 cases, engine failure in 5 accidents, human error in 5 issues, the last one being unknown. Three accidents occurred at night, the 8 others during day-time. 54 persons (34 crew, 20 passengers) have been involved. The outcome has been: 19 dead or disappeared, 4 wounded and 31 uninjured. The aircraft capsized in 8 out of 11 occurrences, almost immediately after ditching in 6 cases, after a delay long enough for all the crew to escape in 2 cases. In one of these last occurrences, all the crew but 1 survivor (13 people) died (probably from cold exposure). In the other one (ditching in shallow warm waters, close to shore) no casualty occurred (10 safe). Escape problems have been reported in 2 accidents (5 people involved), leading to 3 casualties and 1 injured. Localization of survivors has been a major problem in 1 accident (visibility was so poor that only sound signals could be efficient). Author

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HELICOPTER CRASH SURVIVAL AT SEA: UNITED STATES NAVY/MARINE CORPS EXPERIENCE 1977-1990

C. O. BARKER, D. W. YACAVONE, M. S. BOROWSKY, and D. W. WILLIAMSON *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 8 p Sep. 1992

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This paper examines the United States Navy/Marine Corps' (USN) experience with helicopter Class A over water mishaps for the period from 1977 to 1990. There were 137 helicopter Class A flight mishaps over water during this period with an overall survival rate of 83 percent in survivable water crashes. During this period,

the USN developed several programs to improve survivability. The helicopter water survival training device (WSTD or 9-D-5 device) was instituted in 1982. The helicopter emergency escape device system (HEEDS) and the helicopter emergency lighting system (HEELS) were implemented in 1987. This study attempts to answer the question whether or not these programs have, in fact, improved survival since their implementation. In addition, the study reviews the types of operational problems encountered with these devices. The results indicate that the WSTD and HEEDS may have contributed to the statistically significant improved survival seen among Navy aircrew in night crashes. They may have also contributed to the improvement (not statistically significant) in survival among passengers in night crashes. The data were inconclusive with respect to the effects of HEELS because of its not being implemented throughout the fleet. Operational problems with these devices were minor and the benefits of each program far outweigh any risks. In fact, in night crashes aircrew had significantly higher likelihood of survival than passengers who were essentially untrained occupants. Other factors, in addition to the devices studied, may have also affected survival probabilities.

Author

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CRASH EXPERIENCE OF THE US ARMY BLACK HAWK HELICOPTER

DENNIS F. SHANAHAN *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 9 p Sep. 1992

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The U.S. Army UH-60A, Black Hawk, helicopter is the first helicopter designed and built to modern crashworthiness standards. During the design of the Black Hawk, all common injury mechanisms were considered, and significant attempts were made to eliminate foreseeable injury hazards. Most important, the aircraft was designed to withstand an 11.6 m/s (38 ft/s) vertical impact without acceleration injury to the occupants or collapse of structure or high mass items into occupied space. Crew and passengers were provided energy attenuating seats and state-of-the-art restraint systems. Head strike zones were considered and potentially injurious objects excluded from these zones. Additionally, the helicopter was equipped with an advanced crash resistant fuel system. First fielded in 1979, the Black Hawk now has accumulated over 1.1 million hours of flight time. Over the 11-year period from 1 October 1979 to 30 September 1990, there have been 75 class A and B mishaps of the UH-60 resulting in 84 fatalities and 121 personnel injured. Systematic analysis of these crashes has accumulated adequate data to assess the effectiveness of the crashworthiness features of the Black Hawk. The Black Hawk has proven itself to be highly crash survivable even in impacts up to 18.3 m/s (60 ft/s) vertical velocity. Most notable have been its structural integrity, tie-down strength of seats and restraint systems, effectiveness of energy absorbing seats and landing gear, effectiveness of the crash resistant fuel system, and retention of high mass items. Mitigating against this has been a higher than predicted accident rate, a markedly increased vertical velocity at impact compared to most other helicopters in use by the U.S. Army, and a tendency for the roof to collapse in high vertical velocity crashes. Author

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US ARMY HELICOPTER INERTIA REEL LOCKING FAILURES

B. JOSEPH MCENTIRE *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 6 p Sep. 1992

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The inertia reels utilized in U.S. Army helicopters are regulated by MIL-R-8236. This is a performance specification which requires the MA-6 and MA-8 inertia reels to automatically lock when the restraint strap is subjected to an acceleration between 1.5 and 3 G. A review of U.S. Army Safety Center, Fort Rucker, Alabama, mishap data revealed a number of critical and fatal injuries attributed to upper torso flailing that occur in survivable mishaps. Some of these injuries relate directly to the inertia reel either

failing to lock or not automatically locking soon enough. Laboratory sled tests have revealed sporadic failures of the inertia reel in both its auto lock and manual lock positions. Inertia reel failures during high horizontal impacts are believed to be due to high rotational velocities of the ratchet wheel which may prevent the locking pawl from properly engaging the sprocket. Inertia reel failures during high vertical impacts are believed to be caused by the low forward acceleration ($G(\text{sub } x)$) transmitted to the shoulder strap because of torso compression, rolling, and slumping. The lack of inertia reel maintenance and calibration procedures potentially allow the automatic lock sensitivity settings to drift to unacceptable levels over time. The influence of operational conditions (i.e., sand, dust, salt fog, temperature, humidity, etc.) on sensitivity settings are unknown. Field tests of 110 inertia reels at Fort Rucker, Alabama, airfields revealed a 24.5 percent failure to lock at the 3 G requirements. Corrective actions being considered include: (1) establishing calibration and maintenance procedures, (2) revising MIL-R-8236 to incorporate dynamic sled tests and (3) development of an inflatable body and head restraint system.

Author

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US ARMY'S AVIATION LIFE SUPPORT EQUIPMENT RETRIEVAL PROGRAM REAL WORLD DESIGN SUCCESSES FROM PROACTIVE INVESTIGATION

JOSEPH R. LICINA and ARTHUR C. SIPPO (Ohio National Guard, Columbus.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 7 p Sep. 1992
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The U.S. Army Aeromedical Research Laboratory (USAARL) manages the Aviation Life Support Retrieval Program (ALSERP). The purpose of this program is to evaluate and record the efficiency of Aviation Life Support Equipment (ALSE) in the aircraft accident environment with our focus centered on rotary-wing aviation. Personal injury data are correlated with the item of ALSE provided for protection, along with information on the accident kinematics and dynamics. These ALSE items are assessed for damage to determine if the design was adequate, it was manufactured to design, and/or it was properly worn by the crewmember. These data are used by USAARL to identify design deficiencies and to substantiate the need for system improvements. The ALSE sent to USAARL for analysis includes: helmets, crashworthy seats, restraint systems, inertia reels, survival vests, and flight suits from the U.S. Army, and upon request, the Navy, Air Force, Coast Guard, and other government agencies. The primary item of equipment received by USAARL for analysis remains the helmet due to the identified criticality of head trauma in aviation mishaps.

Author

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THE EFFECTIVENESS OF AIRBAGS IN REDUCING THE SEVERITY OF HEAD INJURY FROM GUNSIGHT STRIKES IN ATTACK HELICOPTERS

NABIH M. ALEM, DENNIS F. SHANAHAN, JOHN V. BARSON, and WILLIAM H. MUZZY, III (Naval Biodynamics Lab., New Orleans, LA.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 9 p Sep. 1992
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Accident investigation records at the U.S. Army Safety Center were examined to determine the frequency of gunner injuries incurred from striking the optical sighting systems in the Cobra and Apache attack helicopters during survivable mishaps. Among 105 survivable Cobra crashes during 1972-1990, the sighting system was implicated in 9 minor and 5 major injury cases, and 6 fatalities. The Apache had eight survivable mishaps since 1985, with only one gunner fatality which was attributed to the optical relay tube (ORT). In this Apache mishap and in the 11 Cobra cases where major or fatal injuries occurred, we theorized an airbag would have prevented serious injuries. To explore the role of airbags in reducing the severity of head strikes, we conducted 32 sled tests with and without airbags. In all tests without airbags,

head strikes of the test manikin were sufficiently severe to cause facial fractures, but not necessarily irreversible brain damage. Airbags proved effective in reducing the severity of head strikes against sighting systems. Using mean values of several indicators of injury severity, airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration peak-to-peak swings by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 percent, respectively. The study concludes that an airbag system, specifically designed for the Apache or Cobra, likely would prevent severe or fatal head and chest injuries.

Author

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PRE-FLIGHT RISK ASSESSMENT IN EMERGENCY MEDICAL SERVICE (EMS) HELICOPTERS

R. J. SHIVELY *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 4 p Sep. 1992
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The Emergency Medical Service (EMS) industry has been the subject of several television and newspaper articles (Harvey and Jensen, 1987) which emphasized the negative aspects, (e.g., fatalities and high accident rates), rather than the life saving services performed. Until recently, the accident rate of the EMS industry has been five times as high as that of other civil helicopters. This high accident rate has been coupled with the dramatic rise in the number of programs. The industry has built from a single service at its inception in 1972, to over 180 in 1987 (Spray, 1987), to the point that 93 percent of the contiguous U.S. is now covered by some type of EMS service. These factors prompted the National Transportation Safety Board (NTSB) to study the accidents that occurred between May 11, 1978 and December 3, 1986 (NTSB, 1988). The NTSB report concluded that 'Sound pilot judgment is central to safe flight operations.' They further stated that '... factors unique to EMS helicopter operations--such as the influence of the mission itself, program competition, and EMS program management perspectives--can drastically influence pilot judgment during the EMS mission.' One of the most difficult decisions that a pilot must make is whether to accept or decline a mission. A pre-flight risk assessment system (SAFE) was developed at NASA-Ames Research Center for civil EMS operations to aid pilots in making this decision objectively. The ability of the SAFE system to predict mission risk profiles was tested at an EMS facility. The results of this field study demonstrated that the usefulness of SAFE was highly dependent on the type of mission flown. SAFE is now being modified so that it can 'learn' with each mission flown. For example, after flying a mission to a particular site, an EMS pilot would input information about this mission into the system, such as new buildings, wires, or approach procedures. Then, the next time a pilot flew a similar mission or one to the same area, this additional information would be taken into account in computing a risk assessment.

Author

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CORRELATIONS BETWEEN ENGINEERING, MEDICAL AND BEHAVIORAL ASPECTS IN FIRE-RELATED AIRCRAFT ACCIDENTS

G. WINTERFELD *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 6 p Sep. 1992
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An overview is given over the present situation in aircraft fire safety as it can be derived from the 73rd AGARD-PEP-Meeting devoted to this subject in 1989. It is characterized by increasing interaction between engineering and medical/behavioral aspects. A scenario for aircraft cabin fires is first developed showing that survival times both from the technical and medical point of view are of the same order of magnitude. Although fire-hardening has contributed much to increased survival times the prospects for further progress from this side diminish. Improvements are expected from improved conditions for emergency evacuations and from occupant protection systems. Modeling studies both on engineering

and medical problems are increasingly applied to fire-related problems. The use of water spray systems and smoke hoods are discussed in the paper as well as studies on passenger behavior during evacuations. The combination of medical, behavioral and engineering expertise can be used to promote and optimize passenger protection in fire-related aircraft accidents. Author

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TOWARDS AN INTEGRATED APPROACH TO PROACTIVE MONITORING AND ACCIDENT PREVENTION

MICHAEL H. REJMAN, COLIN J. SYMONDS (City of London Polytechnic, England), and ERIC W. SHEPHERD (City of London Polytechnic, England) /In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 5 p Sep. 1992

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Most traditional accident prevention programmes are based on information learned from accident research. While acknowledging the contribution from this approach, two difficulties can be identified. First, many accidents may be the product of a unique combination of circumstances. Second, the whole process is 'reactive'. In contrast, the research initiative reported here begins with the premise that the components of any organization may already hold much information which could be relevant to safety research and which could be used 'proactively'. A novel feature of the methodology outlines in this programme is that each of the areas can be considered as stand-alone models, capable of providing useful management information in their own right. Taken together, they represent a powerful and integrated approach to an organization's flight safety and accident prevention programme.

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ACCIDENTS AND ERRORS: A REVIEW OF RECENT UK ARMY AIR CORPS ACCIDENTS

MICHAEL H. REJMAN and COLIN J. SYMONDS (City of London Polytechnic, England) /In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 7 p Sep. 1992

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Aircraft accidents can be categorized in a number of different ways (e.g. aircraft type, amount of damage, nature and severity of injuries sustained). Similarly, causation can be attributed to a variety of different factors (e.g. aircrew error, technical failure, operational hazard). Of all the labels used in such schemes, the one which consistently dominates the list of causes is that referred to as 'human error'. In this respect the accident statistics of the UK Army Air Corps (AAC) are no exception. However a label such as 'human error' is not particularly enlightening with regard to accident aetiology, nor does it immediately suggest obvious areas for remedial action. To satisfy these requirements, more detailed categorization schemes are necessary. Three such schemes were applied to a sample of recent AAC accidents for which human factors investigations were available. Two of the schemes had been developed within the field of aviation accident investigation while the third represented recent development within cognitive psychology. To date, around half of the accidents held in the database have been subjected to analysis. Preliminary results suggest that while all the schemes were useful, one particular scheme was easier to implement than the other two, provided a good understanding, and indicated areas for remedial action. The exercise is being extended to cover a larger sample. Author

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PREDICTION OF SUCCESS FROM TRAINING

COLIN J. SYMONDS, MICHAEL H. REJMAN (Army Personnel Research Establishment, Farnborough, England), and ERIC W. SHEPHERD /In AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 8 p Sep. 1992

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Any training system contains information on the past and current performance of its students. However, such systems may also hold predictors capable of estimating the potential of a student.

Failures that occur late during a course result in wasted costs, time and places, and also student career discontent. Therefore identifying the earliest indicators of failure is of primary importance to the operation of an efficient system. Research directed at uncovering these involves the identification of relevant behaviors; classification of the students' behaviors in real life situations; coding the classifications to form data points; and the application of analytic techniques to produce predictive models of behavior. The major emphasis of this paper is to describe attempts to define statistically derived criteria for success and failure in an existing flying training system. It is argued that the introduction of more objective techniques such as those described here may not only make the training system more efficient but may also reduce flight safety risks. Author

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AVIATION SAFETY: PROBLEMS PERSIST IN FAA'S INSPECTION PROGRAM. REPORT TO THE CHAIRMAN, SUBCOMMITTEE ON AVIATION, COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION, HOUSE OF REPRESENTATIVES

20 Nov. 1991 35 p

(GAO/RCED-92-14; B-245206) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The Chairman, Subcommittee on Aviation, House Committee on Public Works and Transportation, asked us to determine whether: (1) the Federal Aviation Administration (FAA) has sufficient information to provide effective oversight of its inspection program; (2) FAA targets its inspection resources to airlines posing the greatest safety risks; and (3) FAA has a system, similar to the one developed by the Department of Defense (DOD), to assess the performance of those commercial airlines with which it contracts. These objectives also allowed us to follow-up on a central finding in our management review, Department of Transportation: Enhancing Policy and Program Effectiveness Through Improved Management (GAO/RCED-87-3, Apr. 13, 1987), concerning the manner in which FAA allocates inspection resources. Author

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CRIMINAL ACTS AGAINST CIVIL AVIATION

1991 90 p

(AD-A258760) Avail: CASI HC A05/MF A01

A compilation of hijackings, bombings, and other significant criminal acts against civil and general aviation interests worldwide is presented. GRA

N93-19941# Wichita State Univ., KS. Inst. for Aviation Research.

CONSUMER INTEREST IN THE AIR SAFETY DATA OF THE AIRLINE QUALITY RATING. TESTIMONY TO THE US HOUSE OF REPRESENTATIVES, COMMITTEE ON GOVERNMENT OPERATIONS, GOVERNMENT ACTIVITIES AND TRANSPORTATION SUBCOMMITTEE

BRENT D. BOWEN and DEAN E. HEADLEY 1 Apr. 1992 20 p (NIAR-92-4) Avail: CASI HC A03/MF A01

The availability of aviation safety information is of vital importance to the air travel consumer. This information can provide both a positive benefit to the air travel consumer and also serve as a key element in the marketing of airline services according to Dr. Tim Becker, a noted airline consultant. At the International Forum on Airline Quality, held March 6 & 7, 1992, in Washington, D.C., Dr. Becker and others reported on the value and benefit of this information to both consumers and airlines alike. Presently, a comprehensive measure of airline safety does not exist. Research verifies that such an indicator is of significant interest to the aviation consumer. The Airline Quality Rating (AQR) is regarded as perhaps the most comprehensive measure of overall airline quality yet conceived. An explanation of these AQR factors which include data regarding airline safety is presented. Author

N93-20928# Construcciones Aeronauticas S.A., Madrid (Spain).
Direccion Proyectos.

NONDESTRUCTIVE INSPECTION OF IN-SERVICE AIRCRAFT
[INSPECCION NO DESTRUCTIVA DE AVIONES EN SERVICIO]
V. CORTES, Y. DEFRUTOS, M. TEJO, and F. FERNANDEZ
1992 9 p In SPANISH Presented at the 7th Congreso
Español y 1st Pirenaico de Ensayos No Destructivos
(ETN-93-93059) Avail: CASI HC A02/MF A01

The rules and the standard procedures established for nondestructive aircraft inspections are summarized. International organizations and aircraft industries produced a users guide to perform inspections. Nondestructive tests are used as a tool to ensure aircraft structure reliability and prevent in-service failures. The critical aircraft structures to be submitted to nondestructive test are defined on the basis of stress analysis, in-service and evaluation tests. The detection of crack initiation and the crack tolerated length are discussed. The choice of nondestructive test method, and the selection and qualification of the personnel to perform the tests are studied. The aircraft quality control also depends on reports concerning malfunctions or problems detected over noncritical structures. It is recommended that such reports be included in the damage assessment and aircraft safety control procedures. ESA

N93-21187# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics Panel.
MISSION PLANNING SYSTEMS FOR TACTICAL AIRCRAFT
(PRE-FLIGHT AND IN-FLIGHT) [SYSTEMES DE
PLANIFICATION DES MISSIONS POUR AVIONS TACTIQUES
(AVANT VOL ET EN VOL)]
Dec. 1992 62 p
(AGARD-AR-313; ISBN-92-835-0697-9) Copyright Avail: CASI
HC A04/MF A01

AGARD Joint-Working Group 15 was established to review mission planning systems and to consider how they are likely to evolve in the future. Its terms of reference specified a program of two phases and the work carried out in the first of these was previously published as AGARD Advisory Report 296. This report covers the work of phase 2. The principle objective of the phase 2 studies was to investigate in detail the distributed mission planning process, dynamic prediction of battle evolution, interoperability, airborne mission planning, mission rehearsal, data filtering/fusion, data protection, communication, testing/validation, artificial intelligence, computer graphics, system architectures, and man/system design. The principle objective was also to assess how these would develop in the future and how such developments would impact upon future mission planning systems. An additional task was to recommend any research and development programs which were identified as being important to future improvements in mission planning systems. Derived from text

N93-21557# Federal Aviation Administration, Atlantic City, NJ.
A MODEL STUDY OF THE AIRCRAFT CABIN ENVIRONMENT
RESULTING FROM IN-FLIGHT FIRES Final Report
B. J. MCCAFFREY (Maryland Univ., Baltimore.), KING-MON TU
(National Bureau of Standards, Washington, DC.), W. J. RINKINEN
(National Bureau of Standards, Washington, DC.), and T. I.
EKLUND Nov. 1992 126 p
(DOT/FAA/CT-90/22) Avail: CASI HC A07/MF A02

A series of tests were conducted to examine the effect of the ventilation on the environment in an aircraft passenger cabin during an in-flight fire. These tests were run in a reduced scale mockup of an aircraft passenger cabin. A propane burner operating at 10 or 30 kilowatts served as the fire source. The simulated seats and the cabin lining material were both noncombustible. The vertical temperature and gas concentration profiles in the cabin were measured as a function of time. Reversing the normal ventilation flow direction by introducing the forced air at the floor level and exhausting it at the ceiling significantly reduced the measured temperatures and gas concentrations. Opening two 152- by 305-millimeter hatches in the end walls at the ceiling level to the outside air resulted in a significant reduction in the measured gas concentrations. Author

N93-21821# Federal Aviation Administration, Atlantic City, NJ.
THE EFFECTIVENESS OF HAND-HELD FIRE EXTINGUISHERS
ON CARGO CONTAINER FIRES

LEROY DICKERSON and DAVID BLAKE Feb. 1993 21 p
(DOT/FAA/CT-TN92/42) Avail: CASI HC A03/MF A01

The purpose of this project was to determine the effectiveness of firefighter intervention using hand-held fire extinguishers on fires in 150- and 800-cubic-foot cargo containers. This test plan was undertaken following a fire in the main deck cargo compartment of a South African Airlines Boeing 747-244B (COMBI) on November 27, 1987. The airplane crashed into the Indian Ocean killing all occupants. A total of 27 tests were performed; 23 in the 150-cubic-foot cargo container series, and 4 in the 800-cubic-foot cargo container series. Three agents were tested--Halon 1211, Halon 1301, and 'loaded stream' water. Only the Halon 1211 agent was partially successful in extinguishing this type of Class A fire. Seven of the 23 fires were extinguished. The rigid cargo containers contained and controlled the test fires through oxygen starvation in 18 of 20 fire tests that were not extinguished. Author

N93-21856# Federal Aviation Administration, Atlantic City, NJ.
PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM
ON EXPLOSIVE DETECTION TECHNOLOGY Final Report
SIRAJ M. KHAN, ed. May 1992 975 p Symposium held in
Atlantic City, NJ, 13-15 Nov. 1991
(DOT/FAA/CT-92/11) Avail: CASI HC A99/MF A10

This report contains opening remarks, kickoff address and keynote address, and 89 papers presented at the First International Symposium on Explosive Detection Technology held 13-15 November 1991, in Atlantic City. The papers deal with the outlook of civil aviation security policy makers in the United States, the United Kingdom, and France and a general introduction to the subject of explosive detection technology. These are followed by papers on physical techniques for explosive detection, chemical and biological techniques for explosive vapor detection, tagging, signal processing and simulation, and testing and field experience. This compendium of useful and practical information was prepared for program managers, scientists, and engineers engaged in research, development, test, and evaluation (RDT&E) in the critical area of global aviation security.

N93-21858# Department of Transport (England). Transport
Security Div.
THE UK PERSPECTIVE ON AVIATION SECURITY
RICHARD H. DONEY In FAA, Proceedings of the First
International Symposium on Explosive Detection Technology p
19-20 May 1992
Avail: CASI HC A01/MF A10

This presentation summary is divided into two parts. The first sets out the views of the UK government on aviation security in general and identifies the major thrusts of its policy. The second part describes how that perspective affects our attitude toward technology. It discusses a number of questions which will have to be satisfactorily answered before we can come to place reliance on explosive detection systems. Author

N93-21859# Federal Bureau of Investigation Academy, Quantico,
VA. Bomb Data Center.
INSIGHTS INTO US DOMESTIC AVIATION
RICHARD REDMAN In FAA, Proceedings of the First International
Symposium on Explosive Detection Technology p 21-22 May
1992
Avail: CASI HC A01/MF A10

The vulnerability of the United States to terrorist attack on its civil aviation infrastructure--aircraft and airports--is discussed. It is argued that perceived successes against the threat of skyjacking have lulled American civil aviation security forces into complacency. As a result of this, an inadequate amount of attention is being placed on passengers and their carry-on baggage, when in the author's opinion it should be placed on the luggage going into the aircraft's baggage-hold. CASI

N93-21861# Science Applications International Corp., Santa Clara, CA.

PRINCIPLES OF NUCLEAR-BASED EXPLOSIVE DETECTION SYSTEMS

TSAHI GOZANI *In* FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 27-55 May 1992

Avail: CASI HC A03/MF A10

This paper reviews the multitude of possible nuclear techniques for explosive detection. From this wide selection, some feasible and a few practical techniques, which can comply with the tough operational requirements, are emerging. The paper describes the requirements for explosive detection sensors and the reasons why nuclear techniques are uniquely responsive to these requirements. The 'nuclear' (i.e., elemental) signatures of explosives, available nuclear reactions, and other nuclear scientific considerations are discussed and demonstrated with the aid of results from sensors or systems which are in advanced stages of R&D or fully derived from text

N93-21862# Westinghouse Science and Technology Center, Pittsburgh, PA.

A REVIEW OF THE DEVELOPMENT OF A LUGGAGE EXPLOSIVE DETECTION SYSTEM

J. BARTKO and F. H. RUDDY *In* FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 56-65 May 1992

Avail: CASI HC A02/MF A10

Based on the favorable results of laboratory tests, the FAA initiated a follow-on program to examine real baggage. For this a detection system was designed and constructed in a trailer. The trailer was transported to four different airports and tests were conducted on a sizeable number of baggage or cargo items. The FAA would add simulated explosives to selected items to provide information on detection rates and false alarm rates. The results of the last two tests are shown. The result pointed to the feasibility of moving to the prototype stage. As a result of the Westinghouse development program, TNA explosive detectors are beginning to play an important role in airport security. Presently, these are four TNA systems established at airports and three others are planned. Improvements vis-a-vis detection of plastic explosives continue to be made. Derived from text

N93-21863# United Kingdom Atomic Energy Authority, Harwell (England). Industrial Technology Branch.

A TRANSPORTABLE LUGGAGE EXAMINATION SYSTEM BASED ON NEUTRON INTERROGATION

DUNCAN BRIAN SYME and GREGORY D. JAMES *In* FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 66-69 May 1992 Sponsored by Ministry of Transport

Avail: CASI HC A01/MF A10

A transportable TNA system suitable for the analysis of passenger luggage was designed, built, and tested on airport luggage. The response of the system to passenger luggage and to luggage containing explosive simulant has enabled the detection performance of the system to be determined. The system uses a distribution of low strength Cf-252 sources and an array of gamma-ray detectors bordering the luggage cavity. This arrangement gives positional information for bulk simulant but is otherwise equally sensitive to bulk and sheet simulant. The system weighs 1.7 tons and can be assembled in about one hour from components weighing less than 30 kg each. The radiological dose close to the analyzer is less than 1.5 micro-Sv/h. Used in conjunction with an X-ray analyzer, the combined system would have low false alarm rate (FAR) and high detection performance. Derived from text

N93-21865# Science Applications International Corp., Santa Clara, CA.

PFNA TECHNIQUE FOR THE DETECTION OF EXPLOSIVES

ZDZISLAW P. SAWA and TSAHI GOZANI *In* FAA, Proceedings of the First International Symposium on Explosive Detection

Technology p 82-103 May 1992

(Contract DTFA03-87-C-00043)

Avail: CASI HC A03/MF A10

Techniques for detecting chemical explosives in passenger luggage must be capable of unequivocally and rapidly identifying the threat in the luggage, with a negligible rate of false alarms. This can be achieved by using nuclear radiations for a non-intrusive measurement of the chemical composition, including mapping of elements of the contents of luggage. Nuclear techniques have been used for a long time to measure chemical compositions. This paper describes a method of detecting explosives, based on the gamma-ray spectrometry in inelastic scattering of pulsed fast neutrons. This interaction leads to excitation of low-lying energy states of nuclei of all the elements of importance in explosives. Derived from text

N93-21866# University of Western Kentucky, Bowling Green. Dept. of Physics and Astronomy.

A PULSED FAST-THERMAL NEUTRON INTERROGATION SYSTEM

GEORGE VOURVOPOULOS, F. J. SCHULTZ (Oak Ridge National Lab., TN.), and J. KEHAYIAS (Tufts Univ., Boston, MA.) *In* FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 104-115 May 1992

(Contract DE-AC05-84OR-21400)

Avail: CASI HC A03/MF A10

Among the various analytical methods that could be used for the detection of explosives, a nuclear technique (thermal neutron activation analysis) was the first to show, in a practical way, the ability to detect small amounts of hidden explosives. Given the fact that there are materials such as melamine equally rich or richer in N than the known explosives, the detection of N was shown to be inadequate in uniquely identifying an explosive. In particular, it was shown that all explosives have a unique O-N profile. By determining the amount of these two elements contained in the interrogated material, the identification of hidden explosives would become more certain. C would be the third element that is common in all the explosives although it does not correlate uniquely with all known explosives. A system therefore that would be able to identify and quantify all three elements, C, N, and O would be able to provide more reliable information about the interrogated material. Among the various options for the C, N, O identification, a pulsed fast-thermal neutron interrogation system is the technique that we utilize. In the following sections we present the advantages of the method, describe the characteristics of the various nuclear reactions, and present the data demonstrating the elemental identification. Derived from text

N93-21870# Science Applications International Corp., Santa Clara, CA.

EXPLOSIVE DETECTION SYSTEM BASED ON ELECTRONIC NEUTRON GENERATOR (ENG)

WILLIS LEE, DAVID B. MAHOOD, PETER RYGE, JOSEPH BENDAHAN, and TSAHI GOZANI *In* FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 151-159 May 1992

Avail: CASI HC A02/MF A10

Under FAA sponsorship, thermal neutron analysis (TNA) explosive detection systems (EDS) for inspection of checked airline baggage were developed and demonstrated. Two parallel development paths were initiated, one using a californium-252 radioisotope source and one using an electronic neutron generator (ENG) consisting of a small particle accelerator with a neutron production target. A second generation development produced the californium-based TNA presently deployed in various airports. Each of these neutron sources has its advantages over the other. The Kaman A711 was the least costly neutron generator capable of providing the necessary neutron flux and was therefore selected for the ENG-EDS development. A prototype EDS using it was designed, constructed, and evaluated. Derived from text

03 AIR TRANSPORTATION AND SAFETY

N93-21895# Science Applications International Corp., Santa Clara, CA.

EXPERIENCE WITH EXPLOSIVE DETECTION SYSTEMS IN AIRPORTS

I. M. BAR-NIR, RUSSELL L. COLE, and D. SUMI /in FAA, Proceedings of the First International Symposium on Explosive Detection Technology p 415-426 May 1992

Avail: CASI HC A03/MF A10

The integration of a high tech based Explosives Detection System (EDS) into the airport environment is described. In particular, the operational aspects are emphasized. The pros and cons of different installation scenarios (e.g., lobby versus tarmac) are discussed. Section 2 describes the operational experience of the thermal neutron analysis (TNA) units in the various locations focusing on the installation and summarizing the performance results. Section 3 describes the operational logic of explosive detection in general and its implementation by the TNA. Conclusions are presented in Section 4. In an Appendix, the performance of an EDS in terms of the relationship between its detection capabilities and its alarm rates is discussed.

Derived from text

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A93-24028

ANALYSIS AND CORRECTION OF IONOSPHERIC TIME DELAY FOR DIFFERENTIAL GPS

JIANPING YUAN and YAN XIONG (Northwestern Polytechnical Univ., Xian, China) Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 11, no. 1 Jan. 1993 p. 13-18. In Chinese. refs

More than half of the GPS error budget comes from ionospheric time delay. Because of the complexity of the atmospheric model, this error can be reduced by only 50 percent or less. A method is presented which permits an additional correction term to be obtained, raising the accuracy to 70-80 percent. Up to now the GPS model has been optimized only for the continental U.S. The algorithm presented here is a function of magnetic latitude and thus provides as good a reduction of error for the rest of the world as for the U.S. C.D.

A93-25170

MAPS AND CHARTS FOR VISUAL AIR NAVIGATION

NEILL LEARY (Civil Aviation Authority, London, United Kingdom) Journal of Navigation (ISSN 0373-4633) vol. 46, no. 1 Jan. 1993 p. 1-9.

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This paper reviews the development and use of maps and charts for visual navigation. The purpose of charts is discussed and the standards set by the ICAO are described. The effectiveness of international standards for chart making is assessed. Chart production, proofreading, and printing are discussed. Constant changes in classifications and difficulties of showing more information on charts has led to many changes in chart production. These changes are discussed as well as the introduction of automated map processing systems. Possible changes and future improvements in chart making are presented. It is concluded that there is an urgent need for review of chart specifications and the development of greater standardization between European states. A.O.

A93-25171

A HISTORY OF VISUAL APPROACH GUIDANCE INDICATOR SYSTEMS IN AUSTRALIA

B. A. J. CLARK and P. ANTONENKO (Defence Science and

Technology Organisation, Aeronautical Research Lab., Melbourne, Australia) Journal of Navigation (ISSN 0373-4633) vol. 46, no. 1 Jan. 1993 p. 49-62. refs

Copyright

The research and development of the T-VASIS system, a method for reducing the hazard incidence of aircraft approach and landing, is reviewed. The development of T-VASIS was the result of a series of experiments on visual landing guidance by ground lighting. The use of ground lights and color coding for landing guidance is described. The development of ground-based visual approach aids and the TVG (tee visual glidepath) concept are discussed. Experiments comparing visual approach aids and the results obtained are discussed and operational comparisons of VASIS and TVIG are given. Improvements of VASIS led to the development of T-VASIS which allowed better tracking accuracy than other systems considered. Further changes of T-VASIS are described. The PAPI system has since been developed and introduced as it has lower installation and operating costs. Despite its high reliability T-VASIS is being displaced by other more cost efficient systems. Future developments in the use of visual approach aids are discussed. A.O.

A93-25172

THE VALUE OF GNSS TO AIRCRAFT OPERATORS

C. G. SENECHAL (Honeywell, Inc., Minneapolis, MN) Journal of Navigation (ISSN 0373-4633) vol. 46, no. 1 Jan. 1993 p. 69-77.

Copyright

Aircraft congestion and safety considerations often result in air routes that do not provide fuel optimum or wind optimum conditions. GNSS (global navigation satellite system) may be used as part of an integrated system to reduce aircraft congestion. The use of satellite-based navigation, phasing out ground-based air navigation systems, and reducing oceanic route separations can reduce costs through more efficient use of airspace. GNSS includes three satellite navigation systems, (GPS, GLONASS, and INMARSAT), information from which is integrated and corrected. Flight test results and surface traffic management in airport terminal areas are assessed. Results indicate that GNSS provides accurate time and position information needed to reduce aircraft separation, reduces time in airport terminals, and allows operation in limited weather conditions. This leads to a decrease in en route congestion as well as operating and maintenance costs while improving safety. A.O.

A93-25173

POSITION REPORTING USING GPS/OMEGA AND INS

J. W. BETHEA and N. D. HALPAIN (Litton Aero Products, Moorpark, CA) Journal of Navigation (ISSN 0373-4633) vol. 46, no. 1 Jan. 1993 p. 105-112.

Copyright

Projected requirements for automatic dependent surveillance (ADS) include the downlinking of certain aircraft flight parameters periodically and upon command from the ground. This will require a primary source of the data such as a flight management system (FMS) and, of course, a radio datalink. This paper provides a description of an existing system that could fulfil much of the interim airborne ADS equipment requirements by using GPS/OMEGA/INS/ACARS for existing aircraft which are not equipped with, or envisioned to be equipped with, SATCOM, FMS or IRS. Author

A93-25480

MANEUVER OPTION MANAGER - AUTOMATED SIMPLIFICATION OF COMPLEX AIR TRAFFIC CONTROL PROBLEMS

WILLIAM P. NIEDRINGHAUS (Mitre Corp., McLean, VA) IEEE Transactions on Systems, Man, and Cybernetics (ISSN 0018-9472) vol. 22, no. 5 Sept.-Oct. 1992 p. 1047-1057. refs

Copyright

Maneuver option manager (MOM) is part of an air traffic control automation project, sponsored by the Federal Aviation

Administration (FAA), in which the computer for the first time assumes responsibility for separation assurance between route aircraft. MOM's purpose is to detect and simplify certain complex air traffic control problems, identified here as sets of interrelated potential pairwise separation problems. MOM determines which of six types of maneuver options is available (free of possible separation problems) for each aircraft. MOM simplifies a complex problem by protecting (for future use) an available maneuver option for one or more of the involved aircraft. Routinely, a single maneuver option resolves multiple pairwise problems. MOM's actions cause complex problems to be iteratively broken down into independent, smaller, and less complex problems. Author

A93-25493
COMMUNICATION SATELLITES FOR COMMERCIAL AIRCRAFT OPERATIONS

Aerospace Engineering (ISSN 0736-2536) vol. 13, no. 1 Jan. 1993 p. 7-12.

Copyright

The Aeronautical Satellite Communication System (SATCOM) is described which is comprised of a total communication system, aircraft communication services, satellite communication avionics, airborne system operation, and avionics subsystem redundancy. It is noted that communication satellites make it possible to reduce flight deck workload and provide air traffic managers with information necessary to improve routing over oceanic areas. SATCOM provides the airlines with worldwide Aircraft Communications Addressing and Reporting System/Airway Communications System coverage and supports expanded passenger cabin services, including passenger telephone, catalog sales, duty-free sales, and FAX communications. The airlines will benefit from improved communications in the areas of air traffic services, airline operational control/administrative communications, and aeronautical public correspondence. O.G.

A93-27909
THE ROLE OF FLIGHT MANAGEMENT IN FUTURE AIR TRAFFIC CONTROL

DREW SHORE (Honeywell, Inc., Phoenix, AZ) Ortung und Navigation (ISSN 0474-7550) no. 3 1992 p. 293-311.

The utilization of the Flight Management System (FMS) in the air traffic management (ATM) environment to increase efficiency and save operating costs for the aviation community is discussed. Current efforts in the U.S. to integrate the FMS with the ground ATM using Datalink to exchange information are described. A vision of a future 'Autonomous Airplane' and its enabling technologies is presented. C.D.

A93-27910
DATA COMMUNICATION FOR AIRBORNE DIFFERENTIAL GPS/GLONASS APPLICATION

MANFRED HAVERLAND (Aerodata Flugmesstechnik GmbH, Braunschweig, Germany) Ortung und Navigation (ISSN 0474-7550) no. 3 1992 p. 319-328. refs

The differential correction methods and data transmission of corrections in the GPS and GLONASS satellite navigation systems are described. Typical applications of these methods are examined. C.D.

A93-27911
INTEGRATION OF A COURSE AND POSITION REFERENCE SYSTEM WITH GPS [INTEGRATION EINES KURS- UND LAGEREFERENZSYSTEMS MIT GPS]

M. BAEUMKER (Bochum, Fachhochschule, Germany) and A. MATTISSEK (LITEF GmbH, Freiburg im Breisgau, Germany) Ortung und Navigation (ISSN 0474-7550) no. 3 1992 p. 359-377. In German. refs

Fiber technology circuits and micromechanical accelerometers are being used to develop a course and position reference system meeting the requirements of ARINC 704 for an inertial navigation system. The development and mechanization of this system are described. An accuracy analysis shows that under standard

conditions the system fulfills the precision requirements of CAT I and, under optimistic assumptions, those of CAT II and III. C.D.

A93-27912
DLR RESEARCH PROGRAM OVERVIEW ON AIRPORT SURFACE MOVEMENT GUIDANCE AND CONTROL

A. BECKER and U. VOELCKERS (DLR, Braunschweig, Germany) Ortung und Navigation (ISSN 0474-7550) no. 3 1992 p. 378-389. Research supported by DLR and Federal German Air Traffic Services

An effort by the German Aerospace Research Establishment DLR to develop new solutions, system components, and procedures for an integrated Surface Movement Guidance and Control system is discussed. The system is meant to assist controllers in their planning and control task as well as give pilot and vehicle drivers better orientation on airport surfaces. This paper examines the development of different suitable sensors for surveillance and identification of ground traffic and the development of a new planning and control system as a help to controllers in tower and ramp control. C.D.

A93-27913
GROUND MOVEMENT AND CONTROL SYSTEM (GMCS)

L. BELGER (Siemens AG, Unterschleissheim, Germany) Ortung und Navigation (ISSN 0474-7550) no. 3 1992 p. 390-395. In German.

An integrated technical solution for the Ground Movement and Control System (GMCS) is considered which can handle increased traffic volume and reduce the work load on air traffic controllers, with safety given the highest priority. The most economical solution is found to consist of a modular concept which guarantees flexible adaptation to specific demands and a stepwise system construction. C.D.

A93-27914
SIPORT DEPCOS AND SIPORT ARRCOS - MORE THAN AN ELECTRONIC AIRSTRIP REPLACEMENT [SIPORT DEPCOS UND SIPORT ARRCOS - MEHR ALS EIN ELEKTRONISCHER FLUGSTREIFENERSATZ]

G. HEINRICH (Siemens AG, Frankfurt am Main, Germany) Ortung und Navigation (ISSN 0474-7550) no. 3 1992 p. 396-405. In German.

DEPCOS (Departure Coordination System) and ARRCOS (Arrival Coordination System), recently developed aids to air traffic controllers, are discussed. The data flow and screen displays of these systems are described. Prospects for their use are addressed. C.D.

A93-28152 National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.

APPLICATION OF NEW GPS AIRCRAFT CONTROL/DISPLAY SYSTEM TO TOPOGRAPHIC MAPPING OF THE GREENLAND ICE CAP

C. W. WRIGHT (NASA, Wallops Flight Facility, Wallops Island, VA) In Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 2-7. refs (Contract RTOP 461-6103)

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A new PC-based GPS flight management display system (GFMS) was developed for Greenland ice cap mapping during the NASA Greenland Ice Sheet mapping experiment, when a total of nine flights were made over four different flight tracks, of which two coincided with ground tracks of the ERS altimeter satellite. In this system, the GFMS inputs the GPS position data to a PC, which generates aircraft automatic pilot steering commands and a cockpit display. The display includes (1) the course deviation indicators for cross-track error and altitude, (2) the flight plan and waypoint map overlay oriented to the aircraft, and (3) various other mission-pertinent numerical data. I.S.

A93-28153

APPLICATION OF ADVANCED GUIDANCE AND NAVIGATION SYSTEMS TO FLIGHT CONTROL OF AIRCRAFT AND FUTURE SPACE VEHICLES

CLINT C. BROWNING and KEVIN W. BRADEN (Honeywell, Inc., Clearwater, FL) /n Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 8-22. refs
Copyright

A joint NASA-Langley/Honeywell flight test project evaluating a differential Global Positioning System (GPS)/Inertial Navigation System (INS) as an approach/landing aid was completed in November 1990. The test objective was to acquire a system performance data base and to demonstrate automatic landing using an integrated differential GPS/INS with radar altimeter aiding for vertical axis guidance. A NASA Boeing 737 testbed was used to evaluate the differential GPS/INS performance which included real-time comparison against MLS-derived position. This paper presents an overview and summary of the results from that flight test and discusses the application and benefits of the integrated INS/GPS to future space vehicles. Author

A93-28155

AIRCRAFT COLLISION AVOIDANCE USING STATISTICAL DECISION THEORY

PATRICK R. WILLIAMS (Hughes Aircraft Co., Ground Systems Group, Fullerton, CA) /n Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 29-34. refs
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Collision avoidance involves the detection of impending collisions of an aircraft with either another aircraft or the ground from radar data and the timely alert of the danger to the pilot or air-traffic controller. The challenge is to provide sufficient warning (timely detections) with minimal false alarms. Radar measurement uncertainties degrade collision detection performance and must be accounted for in the algorithm design. This paper describes a method which uses statistical decision theory to control both missed or late detections and false alarms. The key to the technique is the mathematical description of the aircraft corridor uncertainty region. The corridor uncertainty region is derived from the position and velocity confidence ellipsoid associated with the aircraft radar track via a mapping from six dimensional space to three. By careful choice of the mapping, the minimum volume corridor uncertainty region is derived. This allows for the definition of the optimal collision avoidance decision rule. Since the method is based solely on the statistical properties of an aircraft's position and velocity track, it may be adapted to a variety of collision avoidance or guidance problems involving a radar or beacon-type sensors such as Mode C or Mode S. Author

A93-28156

LASER CENTERLINE LOCALIZER AND LASER GLIDESLOPE INDICATOR FOR VISUAL GUIDANCE ON APPROACH TO LANDING

D. M. SHEMWELL, A. A. VETTER, and R. I. GELLERT (Humbug Mountain Research Labs., Duarte, CA) /n Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 40-47. Research supported by U.S. Navy
Copyright

The Laser Centerline Localizer (LCL) and the Laser Glideslope Indicator (LGI) use a series of low power, but highly visible laser beams to illuminate approach corridors for carrier flight operations. By taking advantage of the ability to precisely shape and direct visible laser beams and by encoding the illuminated paths using color and temporal frequency, direct visual signals which provide a positive on course signal as well as an indication of the direction and degree of deviation from the proper approach are seen by the pilot. The LCL provides a centerline guidance and the LGI

provides descent guidance. This laser visual landing aid (LVLA) system provides the pilot with significantly improved visual cues to aid in the safe landing of the aircraft. The LCL and LGI units have been constructed and field tested. The ability to guide pilots from a range of over 15 miles has been demonstrated. Author

A93-28157

SCANNING LASER AIRCRAFT SURVEILLANCE SYSTEM FOR CARRIER FLIGHT OPERATIONS

A. A. VETTER, D. M. SHEMWELL, R. I. GELLERT, and J. BLACK (Humbug Mountain Research Labs., Duarte, CA) /n Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 48-59. Research supported by U.S. Navy refs
Copyright

The Scanning Laser Aircraft Surveillance System (SLASS) uses two scanning infrared laser beams to illuminate retroreflectors located on aircraft landing gears and hook to determine very precisely the azimuthal, ascension, yaw, roll, and pitch angles of the aircraft in the approach corridor. The range, approach velocity, and aircraft type are also determined. Aircraft configuration is determined by the presence or absence of each return signal, and aircraft type is identified with an encoded sequence of retroreflectors on one landing gear. The position of the aircraft is determined by the time in the scan that the beam encounters the retroreflectors. Author

A93-28193

THE HIGH ACCURACY APPLICATIONS OF THE GPS SYSTEM TO STATIC POSITIONING (LES APPLICATIONS PRECISES DU SYSTEME GPS POUR LE POSITIONNEMENT STATIQUE)

L. DANIEL (IGN, France) Navigation (Paris) (ISSN 0028-1530) vol. 41, no. 161 Jan. 1993 p. 20-29. In French. refs
Copyright

The U.S.'s GPS military satellite positioning system allows highly accurate static and relative target positioning; accuracies are of the order of 1 ppm to 0.01 ppm. An account is presently given of international efforts to establish and operate a civilian GPS global-tracking network, which involves the distribution of high accuracy ephemeris units to prospective users. O.C.

A93-28194

GNSS - A GLOBAL SYSTEM OF SATELLITE-AIDED NAVIGATION (LE GNSS - UN SYSTEME MONDIAL DE NAVIGATION PAR SATELLITES)

JEAN-MARIE DURAND (CNES, Toulouse, France) Navigation (Paris) (ISSN 0028-1530) vol. 41, no. 161 Jan. 1993 p. 31-49. In French. refs
Copyright

The ICAO has adopted the Global Navigation Satellite System (GPSS) as a future self-sufficient means for horizontal en-route, terminal, and nonprecision approach phases of commercial flight. Attention is given to the Ranging GNSS Integrity Channel concept, the current state of international GNSS project coordination, and the technical difficulties that must be overcome in bridging operation under global and regional conditions. O.C.

A93-28195

DIFFERENTIAL GPS AND ITS APPLICATIONS IN THE AERONAUTICAL REALM [GPS DIFFERENTIEL ET SES APPLICATIONS DANS LE DOMAINE AERONAUTIQUE]

HENRY GAILLARD (Dassault Electronique, Saint-Cloud, France) Navigation (Paris) (ISSN 0028-1530) vol. 41, no. 161 Jan. 1993 p. 50-61. In French.
Copyright

An overview is given of the components and operational characteristics of the differential-GPS satellite navigation system from the standpoint of both commercial and military aviation. Although delays associated with the Space Shuttle launch schedule have set back the date of initial D-GPS operations to 1994, some \$20 million will have been spent on the program's implementation by the year 2000. O.C.

A93-28197

**CAN ONE DO WITHOUT THE MAGNETIC REFERENCE?
[PEUT-ON S'AFFRANCHIR DE LA REFERENCE
MAGNETIQUE?]**

ANDRE FLEURY (Inst. Francais de Navigation, Paris, France)
Navigation (Paris) (ISSN 0028-1530) vol. 41, no. 161 Jan.
1993 p. 68-74. In French.
Copyright

An evaluation is given of the plausible bases for continued use of magnetic navigation equipment by aircraft, in the wake of the introduction of satellite-navigation and inertial-navigation systems of great reliability and accuracy. Attention is given to radio-aided navigation systems and the opportunities designed into such recent commercial aircraft as the B747 and A310 for reversion to these more conservative types of navigation. O.C.

A93-28198

**SATCOM PACIFIC OCEAN TRIALS [L'EXPERIMENTATION
SATCOM PACIFIQUE]**

YVES MEUSBERGER, PASCAL SENARD, and JEAN-CLAUDE VALENTIN (Service Technique de la Navigation Aerienne, Paris, France) Navigation (Paris) (ISSN 0028-1530) vol. 41, no. 161 Jan. 1993 p. 75-89. In French.
Copyright

The PRODAT project conducted by the ICAO in 1986 vindicated the use of Automatic Dependent Surveillance (ADS) in flight trials over the Pacific involving Japan-Australia-U.S. commercial aviation routes. ADS transmits aircraft navigation sensor-derived ATC data over GEO satellites. Plans for future implementation of ADS were unanimously approved by the ICAO in September, 1991. O.C.

A93-28219

**RESULTS FROM A VHF IMPULSE SYNTHETIC-APERTURE
RADAR**

ROGER S. VICKERS, VICTOR H. GONZALEZ, and ROBERT W. FICKLIN (SRI International Geoscience and Engineering Center, Menlo Park, CA) In Ultrawideband radar; Proceedings of the Meeting, Los Angeles, CA, Jan. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 219-225.
Copyright

In late 1990, a synthetic aperture radar was built and operated in the VHF using impulse excitation to the antennas. The resulting transmitted spectrum extended from 100 to 600 MHz, thus qualifying as an ultra-wideband system. The radar is capable of recording several channels with differing bandwidths all from the same pulse, resulting in images which are in perfect registration. Early, uncalibrated results were reported in 1991. In this paper, we present new results from flights of the radar. The algorithm for production of the SAR images is described, and the effects of altering such parameters as integration angle and center frequency are discussed. Author

A93-28392

MANAGING THE WORLD'S AIR TRAFFIC

THEODORE R. SIMPSON (Advanced System Technologies, Inc., Englewood, CO) Aerospace America (ISSN 0740-722X) vol. 31, no. 3 March 1993 p. 14-17.
Copyright

Current technologies and near-term advancements are expected to make possible, by the turn of the century, a global ATC management system that will allow pilots to fly between any two points on the globe, along a flight path entirely of their choosing, and subject only to the weather and the presence of other aircraft (as, say, in the vicinity of the busiest airports). A survey of those navigation and communication satellite-based technologies is presented. O.C.

A93-29474

**DATALINKS - CIVIL AIRCRAFT; PROCEEDINGS OF THE
CONFERENCE, LONDON, UNITED KINGDOM, NOV. 24, 1992**
London Royal Aeronautical Society 1992 41 p.
(ISBN 1-85768-075-8) Copyright

While many initiatives have already been taken at the international level, as well as in national R&D programs, to promote the implementation of data links, there exists a widening gap in the data-interchange technology available to the aircraft and ground systems. The present conference discusses air-ground data communications, UK data link implementation-related activities, the current status of a European data-link implementation program, and an air-to-ground data link for civil aviation. (No individual items are abstracted in this volume) O.C.

A93-29596

**SOME LIMITATIONS ON THE EFFECTIVENESS OF AIRBORNE
ADAPTIVE RADAR**

EDWARD C. BARILE, RONALD L. FANTE, and JOSE A. TORRES (Mitre Corp., Bedford, MA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251) vol. 28, no. 4 Oct. 1992 p. 1015-1032. refs
(Contract F19628-89-C-0001)
Copyright

It is shown that internal clutter motion, aircraft crabbing, scattering from near-field obstacles, and channel mismatch can limit the effectiveness of space-time processing in eliminating airborne clutter. An analytical expression is developed to show how each of these effects produces a deterioration in the signal-to-clutter-plus-noise ratio achievable. By studying the spectral decomposition of the covariance matrix, it is found that the effects of both internal clutter motion and crabbing can either be compensated by artificially adding noise or by processing more pulses. A near-field obstacle produces a spread of the clutter into all of sine azimuth-Doppler space. It is shown that the space-time processor attempts to compensate for this effect by placing a near-field null on the obstacle. Thus, adding more elements is much more effective in eliminating this effect than is processing more pulses. Channel mismatch can be alleviated by controlling the dispersive errors more tightly and by increasing the number of receive elements. I.E.

A93-29599

**OBSERVABILITY ANALYSIS OF PIECE-WISE CONSTANT
SYSTEMS. I - THEORY**

DRORA GOSHEN-MESKIN (Israel Aircraft Industries, Ltd., Lod) and ITZHACK Y. BAR-ITZHACK (Technion - Israel Inst. of Technology, Haifa) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251) vol. 28, no. 4 Oct. 1992 p. 1056-1075. refs
Copyright

An approach is presented to the analysis of the observability of certain time-varying linear systems whose variation can be expressed in a piecewise constant manner, circumventing the difficulty associated with the investigation of the observability of time-varying systems. An observability matrix is developed for a continuous and a discrete time representation, as well as a stripped observability matrix which simplifies the analysis for cases in which the use of this matrix is legitimate. This method is applied to the analysis of in-flight alignment (IFA) of inertial navigation systems whose estimability is known to be enhanced by maneuvers, demonstrating the validity of this approach to the analysis of IFA. I.S.

A93-29600

**BEARINGS-ONLY AND DOPPLER-BEARING TRACKING USING
INSTRUMENTAL VARIABLES**

Y. T. CHAN and STEPHEN W. RUDNICKI (Royal Military College of Canada, Kingston) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251) vol. 28, no. 4 Oct. 1992 p. 1076-1083. refs
Copyright

In bearings-only tracking (BOT) or Doppler and bearing tracking (DBT), both common passive sonar problems, the measurement equations are nonlinear. To apply the Kalman filter, it is necessary either to linearize the equations or to embed the nonlinearities into the noise terms. The former sometimes leads to filter divergence, while the latter produces biased estimates. A

formulation of BOT and DBT which has a constant state vector and simplifies the tracking problem to one of constant parameter estimation is given. The solution is by the instrumental variable method. The instrumental variables are obtained from predictions based on past measurements and are therefore independent of the present noisy measurements. The result is a recursive, unbiased estimator. The theoretical developments are verified by simulation, which also shows that the formulation leads to near optimal estimators whose errors are close to the Cramer-Rao lower bound (CRLB). I.E.

A93-29639

THREE-DIMENSIONAL CELLULAR SYSTEMS FOR AERONAUTICAL MOBILE RADIO COMMUNICATIONS

SAID M. ELNOUBI (Mitre Center for Advanced Aviation System Development, McLean, VA) IEEE Transactions on Vehicular Technology (ISSN 0018-9545) vol. 41, no. 4 Nov. 1992 p. 322-328. refs

Copyright

A new technique for designing three-dimensional cellular systems for VHF air/ground communications is proposed to solve the problem of frequency congestion for air traffic control (ATC) and flight services. In VHF air/ground communication systems, a radio line of sight (RLOS) between the aircraft and ground station must exist. The frequency reuse distance is reduced by using the radio horizon to block cochannel interferences. In the proposed system, cells of different sizes to cover different altitude ranges are separated by different reuse distances. With nine groups of channels, the altitude range from 740 ft to 45,000 ft can be covered without interference. The proposed system utilizes the spectrum efficiently by covering a certain airspace according to a well-organized plan with the minimum number of frequency channels and cell sites. Thus, it has more frequency reuse than the current systems. I.E.

N93-19843# General Accounting Office, Washington, DC. Resources, Community, and Economic Development Div.

AVIATION SAFETY: USERS DIFFER IN VIEWS OF COLLISION AVOIDANCE SYSTEM AND CITE PROBLEMS. REPORT TO THE CHAIRMAN, SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, HOUSE OF REPRESENTATIVES

16 Mar. 1992 19 p
(GAO/RCED-92-113; B-247195) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The Chairman, Subcommittee on Investigations and Oversight, Committee on Science, Space, and Technology, asked us to review a number of issues related to the Traffic Alert/Collision Avoidance System (TCAS). Specifically we were asked to develop information on: (1) pilot's and air traffic controllers' view on TCAS; (2) FAA's actions to address TCAS's problems; and (3) key aspects of FAA's software engineering approach for TCAS, including FAA's plans to verify and validate the system. To obtain information on the status of TCAS's installation and reported operational problems, we reviewed relevant sections of the Federal Aviation Act of 1958, as amended, and FAA's TCAS regulations, as well as advisory circulars and various reports and position papers that provided information on TCAS operations and issues. We reviewed statistics developed by FAA's TCAS Transition Program to determine the number of altitude deviations and inappropriate TCAS advisories reported by pilots and air traffic controllers. Author

N93-19924# Test Wing (6510th), Edwards AFB, CA.

TESTING OF AN AUTOMATIC, LOW ALTITUDE, ALL TERRAIN GROUND COLLISION AVOIDANCE SYSTEM

M. A. SKOOG and T. H. ASCOUGH /in AGARD, Flight Testing 20 p Oct. 1992

Copyright Avail: CASI HC A03/MF A04

Flight test results and analysis techniques are presented for an automatic All Terrain Ground Collision Avoidance System (AT GCAS). The AT GCAS was flight demonstrated on the Advanced Fighter Technology Integration (AFTI)/F-16 and hosted on a production digital F-16 flight control system. Over 200 automatic

recoveries were initiated at dive angles up to 50 degrees, all bank angles, and airspeeds ranging from 270 to 570 knots. New methods were developed to analyze data, allowing identification of subsystem error contributions. The resulting system performance is presented with conclusions. Author

N93-19966# Federal Aviation Administration, Atlantic City, NJ.

A SIMULATION STUDY OF THE EFFECTS OF COMMUNICATION DELAY ON AIR TRAFFIC CONTROL Final Report, Nov. 1989 - Aug. 1990

ERIC D. NADLER, ROBERT DISARIO, PETER MENGERT, E. D. SUSSMAN, and GERARD SPANIER Sep. 1992 168 p
(AD-A258593; DOT-VNTSC-FAA-90-5; DOT/FAA/CT-90/6) Avail: CASI HC A08/MF A02

This study was conducted to examine the impacts of voice communications delays characteristic of Voice Switching and Control System (VSCS) and satellite communications systems on air traffic system performance, controller stress and workload, and communications disruptions. To accomplish this a simulation was developed and performed at the Federal Aviation Administration (FAA) Technical Center. The simulation used scenarios constructed from records of Live air traffic at five adjacent Atlanta Air Route Traffic Control Center (ARTCC) sectors. Nine full performance level air traffic control specialists from the Atlanta ARTCC sectors simulated participated as subjects. Four delay levels were employed corresponding to: current equipment with and without satellite Link, and VSCS with and without satellite Three Levels of communications workload were used based on 70 percent, 90 percent, and 110 percent of reference values for the actual sectors. VSCS delays were not found to have any statistically significant impact on any measure. Satellite delays were found to be associated with a statistically significant increase in one kind of communication disruption (step-ons) at the highest level of communications workload used in the study. GRA

N93-20164# Federal Aviation Administration, Washington, DC. **NATIONAL AIRSPACE SYSTEM: AIR TRAFFIC CONTROL AND AIRSPACE MANAGEMENT OPERATIONAL CONCEPT NAS-SR-132**

WILLIAM TRENT, THOMAS PICKERELL, and HAROLD NELSON, JR. Dec. 1992 291 p
(Contract DTFA01-91-Y-01004) (DOT/FAA/SE-92/5) Avail: CASI HC A13/MF A03

The NAS has a responsibility to assist in the safe and efficient flow of traffic from departure aerodrome (or entrance to the system) to destination aerodrome (or exit from the system). It provides flight control services in the en route, terminal, and oceanic airspace. It also provides search and rescue services to locate lost aircraft. In order to exercise control of aircraft, the NAS must have information about the expected routes, times, altitudes of flight, and aircraft characteristics. It must also have information about current location, altitude, and track for each participating aircraft in the system. This concept, and the other seven operational concepts, will complete the description of the system requirements as described in the NASSRS. The eight operational concepts are: Communications (NAS-SR-136); Navigation (NAS-SR-134); Monitoring (NAS-SR-133); Maintenance and Support (NAS-SR-137); System Effectiveness (NAS-SR-138); Air Defense and Law Enforcement Surveillance (NAS-SR-135); Flight Planning (NAS-SR-131); and Air Traffic Control and Airspace Management (NAS-SR-132). Author

N93-20582# Federal Aviation Administration, Oklahoma City, OK. Civil Aeromedical Inst.

COMPARISON OF PERFORMANCE ON THE SHIPLEY INSTITUTE OF LIVING SCALE, AIR TRAFFIC CONTROL SPECIALIST SELECTION TEST, AND FAA ACADEMY SCREEN Final Report

PAMELA S. DELLAROCO, NELDA MILBURN, and HENRY W. MERTENS Nov. 1992 9 p
(AD-A259249; DOT/FAA/AM-92/30) Avail: CASI HC A02/MF A01

This study was conducted to establish norms for ATCS

personnel on a group test of intellectual functioning, the Shipley Institute of Living Scale (SILS), to screen subjects for future research on the effects of Air Traffic Control Specialist (ATCS) related stressors on complex task performance. The SILS provides both verbal (Vocabulary) and cognitive performance (Abstraction) measures of general intellectual functioning. The relationship between SILS and performance of ATCS's in the FAA Academy Nonradar Screen Program (NSP) was also assessed. ATCSs undergo a two-stage selection process: (1) the Office of Personnel Management (OPM) Air Traffic Control Specialist Battery and (2) the NSP, a nine-week performance-based screening course at the FAA Academy. The Shipley was administered to three entering groups of new hires ($N = 563$) upon their arrival at the FAA Academy. SILS scores were converted to estimated WAIS-R Full Scale intelligence scores. The SILS measures were compared to scores on the OPM selection battery and in the NSP. SILS Total, Abstraction, and estimated WAIS-R scores were better predictors of NSP performance than were the SILS Vocabulary Subtest scores. Moderate correlations were found between the final academy score and the SILS and OPM measures. ATCS applicants scored higher on the Abstraction Subtest than the Vocabulary Subtest. ATCSs tend to be above average in intelligence, and tests of cognitive performance tend to be better predictors of overall NSP performance than verbal measures. The normative data can serve as an effective general intelligence screen for subjects involved in ATCS-related research. GRA

N93-20612# Federal Aviation Administration, Atlantic City, NJ.
DATA MULTIPLEXING NETWORK (DMN). PHASE 3:
EQUIPMENT OPERATIONAL TEST AND EVALUATION (OT/E)
INTEGRATION TEST REPORT

WAYNE E. BELL and PHILLIP P. HOANG Mar. 1993 27 p
 (DOT/FAA/CT-TN92/49) Avail: CASI HC A03/MF A01
 This test report contains the test results of the Operational Test and Evaluation (OT&E) integration testing of Data Multiplexing Networking (DMN) Phase 3B Commercial Off-The-Shelf (COTS) equipment. The OT&E integration testing was accomplished by conducting unit level tests at the Federal Aviation Administration (FAA) Technical Center, and integration tests at the Air Route Traffic Control Center (ARTCC) in Minneapolis, Minnesota. Based on the test results, it is concluded that the Motorola Codex COTS equipment performed its function of providing data exchange between NAS facilities and is considered qualified for the NAS environment. Author

N93-20749# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Abt. fuer Funkortung und Nachrichtenverarbeitung.
DEVELOPMENT OF A REALTIME DGPS SYSTEM [AUFBAU EINES ECHTZEIT-DGPS-SYSTEMS]

F. HEIMBERG (Technische Univ., Hanover, Germany), C. MEIER (Technische Univ., Brunswick, Germany), T. MUELLER (Technische Univ., Brunswick, Germany), and M. POPPE Feb. 1992 43 p In GERMAN
 (ISSN 0939-298X)
 (DLR-MITT-92-06; ETN-93-92408) Avail: CASI HC A03/MF A01;
 DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

It is shown that the proposal for a standardized, user independent Differential Global Positioning System (DGPS) is realizable. The experimental system is to be the basis for research in the field of the VHF correction datalink, the real time navigation software, and wave propagation effects on the system behavior in an airport scenario. ESA

N93-21004# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Abt. fuer Systemtechnik und Navigation.

FUNDAMENTALS OF ADAPTIVE ANTICIPATION TECHNIQUES FOR THE DETECTION OF THREATENING AIR TRAFFIC CONFLICTS: INVESTIGATION OF THE HORIZONTAL PROXIMITY SITUATION IN THE CASE OF EXPECTED HEADING CHANGES [GRUNDLAGEN DER ERWARTUNGSORIENTIERTEN KONFLIKTVORHERSAGE IM LUFTVERKEHR: UNTERSUCHUNG DES HORIZONTAL EN ANNAEHERUNGSVERHALTENS IM FALLE VON ERWARTETEN KURSAENDERUNGEN]

WILFRIED GERLING 13 Nov. 1991 69 p In GERMAN
 (ISSN 0939-298X)
 (DLR-MITT-91-21; ETN-93-91921) Avail: CASI HC A04/MF A01;
 DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

The proposed concept of adaptive short term conflict prediction in air traffic control takes into consideration both actual radar data and known plans or events. The continuation of individual flight tracks is to be predicted on the basis of expected changes in the aircraft flight profiles. Some methods of differing accuracy for the predetermination of the developing horizontal distance between two aircraft are described. The presented prediction methods may serve as a basis for the construction of a rule basis for the purpose of isolating individual pairs of aircraft, which are proceeding towards aerial conflict. ESA

N93-21671# Software Productivity Consortium, Herndon, VA.

DOMAIN ENGINEERING VALIDATION CASE STUDY:
SYNTHESIS FOR THE AIR TRAFFIC DISPLAY/COLLISION
WARNING MONITOR DOMAIN VERSION 01.00.03

NEIL BURKHARD, JEFF FACEMIRE, GRADY CAMPBELL, JIM OCONNOR, and STEVE WARTIK Nov. 1992 375 p
 (Contract MDA972-92-J-1018)
 (AD-A259407; SPC-92050-CMC) Avail: CASI HC A16/MF A03

This case study exemplifies Synthesis guidance, as provided in the 1991 Synthesis Guidebook (SPC 1991c), and its application to the Air Traffic Display/Collision Warning Monitor (ATD/CWM) domain. The synthesis guidance will be one volume of the 1992 guidebook for reuse-driven software development processes. Both domain engineering and application engineering work products are covered. Even though the Synthesis reuse process is an iterative process, this case study presents only the work products of the final iteration. This case study provides some discussion of how these work products were refined or evolved from previous versions. The case study helps line engineers and technologists understand the application of the Synthesis reuse-driven software development process by providing examples of the work products created by applying Synthesis to a particular domain constituting a business area focus. In this context, a domain is a set of applications. Derived from text

N93-21759# Princeton Economic Research, Inc., NJ.
PRELIMINARY STUDIES OF PLANNING AND FLIGHT STRIP
USE AS AIR TRAFFIC CONTROLLER MEMORY AIDS Report,
Nov. 1991 - May 1992

CAROLINA ZINGALE, STAN GROMELSKI, and EARL S. STEIN
 Sep. 1992 97 p
 (Contract DTFA03-89-C-00050)
 (DOT/FAA/CT-TN92/22) Avail: CASI HC A05/MF A02

Preliminary studies were conducted with novice participants (aviation students) to investigate the effects of memory strategies (planning and flight strip management) on Air Traffic Control (ATC) performance. Participants were trained to use TRACON 2, an ATC simulator for the personal computer, and were then tested in three experiments. The first two experiments tested whether having an opportunity to plan control strategies and having increased planning time influenced performance. The results did not indicate that performance improved under these conditions. Individuals differed widely in their performance regardless of test condition, suggesting that individual strategies may have influenced performance to a greater extent than did the test conditions. Methods which allow

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

for the analysis of individual strategies should be used to conduct future research in these areas. The third experiment tested the effect of flight strip management (note writing) on performance and on memory for critical information. Correlations revealed that participants who wrote more on strips tended to perform better and also tended to remember more of the commands they had issued to aircraft, suggesting an important role for active flight strip manipulation. Overall, this work demonstrated that a PC-based simulator can provide a suitable environment in which to test issues in ATC. Realistic scenarios can be developed to accommodate a range of performance abilities, making this a potentially suitable testing device for use with actual air traffic controllers. Author

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A93-24032

A MULTI-FUNCTIONAL COMPUTER-AIDED AIRCRAFT EXTERIOR SHAPE MODELLING PROTOTYPE SYSTEM

MINGYAN GAO, WEN LU, and SHENGMIN WEI (Northwestern Polytechnical Univ., Xian, China) Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 11, no. 1 Jan. 1993 p. 67-72. In Chinese. refs

A multiknot spline-based multifunctional geometric modelling system has been developed for use in modeling aircraft from the initial sketch to the complex geometric design defining the exterior curved shapes of the aircraft. Use of the method saves up to 40 percent of CPU time and allows more complex shapes to be generated, due to an explicit local expression provided by the method. A multiknot blending function interpolant scheme to handle nonrectangular surface patches is provided. C.D.

A93-24492#

ON THE MAXIMUM RANGE OF FLYING WINGS

PETER J. TORVIK (USAF, Inst. of Technology, Wright-Patterson AFB, OH) Aug. 1992 9 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs (AIAA PAPER 92-4223)

The classical equations for determining the maximum range of aircraft with propeller and jet propulsion systems are reviewed, along with previous work conducted to determine the optimal division of aircraft volume between fuselage and wing components. That the jet powered flying wing configuration produces optimal range only for limited geometries is confirmed. The optimal range of aircraft employing high bypass jet engines is explored, and found to lead to a broader range of design parameters for which the flying wing design produces maximum range than is the case when a pure jet system is used. Author

A93-24741*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPREHENSIVE ANALYSIS OF BEARINGLESS ROTORS - MODEL DEVELOPMENT AND EXPERIMENTAL CORRELATION OF MODES, RESPONSE, TRIM AND STABILITY

V. JAMBUNATHAN and V. R. MURTHY (Syracuse Univ., NY) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract NAG1-759)

(AIAA PAPER 93-0624) Copyright

A generic mathematical model that is capable of accurately modeling the multiple load path bearingless rotor blade is developed. A comprehensive, finite element based solution for the natural vibration of the rotor blade is developed. An iterative scheme based on harmonic balance is used to evaluate the nonlinear response of the rotor to control inputs and a Newton-Raphson procedure is employed to evaluate the trim of

rotorcraft. Linearized perturbation model of the nonlinear system are presented. The model is validated by comparing with existing whirl tower, wind tunnel and flight test results of BMR/BO-105 helicopter. Frequencies of two bearingless rotor blades compare well with results from experiments. Nonlinear response and trim results are presented for the bearingless BMR/BO-105 rotor. Aeroelastic stability in forward flight, evaluated using floquet theory agrees with test data in general. Author

A93-24742*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

OPERATIONAL AND RESEARCH ASPECTS OF A RADIO-CONTROLLED MODEL FLIGHT TEST PROGRAM

GERALD D. BUDD (NASA, Flight Research Center, Edwards, CA), RONALD L. GILMAN, and DAVID EICHSTEDT (PRC, Inc., Edwards, CA) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0625) Copyright

The operational and research aspects of a subscale, radio-controlled model flight test program are presented. By using low-cost free-flying models, an approach was developed for obtaining research-quality vehicle performance and aerodynamic information. The advantages and limitations learned by applying this approach to a specific flight test program are described. The research quality of the data acquired shows that model flight testing is practical for obtaining consistent repeatable flight data. Author

A93-24838#

EXPERIMENTAL ASSESSMENT OF AIRFRAME DAMAGE DUE TO IMPACTING ICE

DANIEL A. DOOGE, SARABJEET SINGH, K. C. MASIULANIEC, and KENNETH J. DEWITT (Toledo Univ., OH) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0751) Copyright

A parameter study was performed of the deformation of a planar aluminum sheet (2024T3) when subjected to varying masses and velocities of ice spheres. The damage is analyzed both qualitatively and quantitatively as a function of increasing impact momentum/impulse. Incoming kinetic energy was found to correlate with expected damage. Results show that spheres of 'ice cube' type ice may be used to simulate reasonably well the damage that would occur with the irregularly shaped fragments of a forced shed of naturally occurring accreted ice. These results are compared to impact from shed ice particles obtained at the NASA-Lewis Icing Research Tunnel. O.G.

A93-25174

ZEN AND THE ART OF AIRPLANE SIZING

ANTHONY P. HAYS (Lockheed Aeronautical Systems Co., Marietta, GA) AIAA Student Journal (ISSN 0001-1460) vol. 30, no. 4 Winter 1993 p. 2-6. refs Copyright

A quasi-empirical approach to the problem of aircraft sizing is described which is simple yet still provides useful answers. The approach avoids the great amounts of input data required by computers doing mission analysis and weight buildup calculations. The present approach requires only a pocket calculator. C.D.

A93-25250

FIFTY YEARS OF TANDEM ROTOR HELICOPTER ENGINEERING

W. E. HOOPER (Boeing Defense and Space Group, Philadelphia, PA) Vertiflite (ISSN 0042-4455) vol. 39, no. 1 Jan.-Feb. 1993 p. 36-44, 46-58. refs Copyright

A comprehensive development history is presented for the configurational features and mechanical subsystems of tandem-rotor helicopters, which, as in the cases of the CH-46 and CH-47, have tended to be among the larger, heavier-payload cargo and transport helicopters. Attention is given to (1) the mechanical drivetrains devised to power both the forward and aft rotors from a single located engine installation, (2) the single and

double planetary stage main rotor transmission systems, and (3) the control and stabilization systems, devised for representative helicopters of this type. O.C.

A93-25357

SAAB 2000 - AN EXERCISE IN GROWTH AND COMMONALITY

Air International (ISSN 0306-5634) vol. 44, no. 2 Feb. 1993 p. 65-70.

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The present design features review and performance evaluation for the Saab 2000 50-seat twin-turboprop commuter airliner noted the degree of commonality it retains in its structures and subsystems with the Saab 340 regional airliner. Cabin seating is three abreast, and propeller noise is minimized through the use of slow-turning, scimitar-shaped propellers; the engines are located on the wings at a point twice as far from the fuselage as those of the Saab 340. The cockpit instrument display consists of six CRTs. O.C.

A93-25362

DESIGN OF AN ADVANCED NACELLE FOR A VERY HIGH BYPASS RATIO ENGINE

J.-L. LECORDIX, J.-M. GIPPET, and J.-L. DUPARCQ (SNECMA, Moissy-Cramayel, France) Aeronautical Journal (ISSN 0001-9240) vol. 96, no. 960 Dec. 1992 p. 387-394. Research supported by DGA refs

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An exceptionally short and slender nacelle configuration has been designed for very high-bypass ratio (11:1) turbofans in order to diminish weight and reduce drag. The geometry of the nacelle, whose thrust-reversal system is on the engine core's cowl, was optimized via CFD codes. The external drag and length of the fan cowl have both been reduced by over 30 percent, relative to the most advanced conventional nacelle. O.C.

A93-25491

FUTURE SUPERSONIC TRANSPORT STUDIES AT AEROSPATIALE

DUDLEY COLLARD (Aerospatiale, Div. Avions, Paris, France) Cockpit (ISSN 0742-1508) Oct.-Dec. 1992 p. 5-19.

Copyright

In virtue of its previous experience of the difficulties associated with the construction of a first-generation SST, the manufacturer whose exploratory efforts toward a second generation vehicle are presently detailed has chosen to design for the same cruise Mach number as Concorde: this will allow constant cross-checking between novel design concepts and well-studied experience. An evaluation is made of the development status of the new SST's powerplant installation, structural design, and possible structural materials. O.C.

A93-25495

SPEED, RANGE BOOST SAAB 2000'S APPEAL

DAVID M. NORTH Aviation Week & Space Technology (ISSN 0005-2175) vol. 138, no. 5 Feb. 1, 1993 p. 44-48.

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The Saab 2000 is a twin-turboprop, 50-passenger commuter airliner employing state-of-the-art cockpit display technology. Six color CRTs are employed, and a single power lever controls engine throttle and propeller pitch settings. Deliveries will begin with 10 aircraft in 1993, followed by at least 15 in 1994; there are currently 46 firm orders and 148 options. With 50 passengers and long-range cruise power settings, maximum range is 1400 naut. mi. Flight test impressions and a tabulation of performance specifications are presented. O.C.

A93-25521*# National Aeronautics and Space Administration, Washington, DC.

CURRENT TECHNOLOGIES FOR WAVERIDER AIRCRAFT

PAUL E. HAGSETH (General Dynamics Corp., Fort Worth, TX) and ISIAH M. BLANKSON (NASA, Washington) Jan. 1993 15

p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0400) Copyright

'Waverider' hypersonic vehicle configuration-related technologies are presently discussed for both the Mach 4-7 and Mach 8-12 speed regimes. These technologies encompass engine cycle selection, propulsion system integration, thermal management, structural design, materials selection, and stability/control. The integration of the propulsion system may require novel techniques for efficient blending of inlet and nozzle flows with forebody and afterbody contours. O.C.

A93-25522#

A HYPERSONIC WAVERIDER RESEARCH VEHICLE

J. W. HANEY, R. T. CERVISI, A. C. GRANTZ, and T. R. SMITH (Rockwell International Corp., Downey, CA) Jan. 1993 7 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0402) Copyright

A study is undertaken to develop a concept for a hypersonic research vehicle using waveriding aerodynamics. Both hydrogen and hydrocarbon fuels are considered. Tradeoffs are made on acceleration approaches and launch concepts. This study resulted in a hypersonic research vehicle (HRV) concept with the capability of hypersonic flight testing up to Mach 14. This vehicle, air launched at Mach 3 from a NASA SR71, provides hypersonic testing up to Mach 10. Air launched from the NB52 at Mach 0.8 with an external booster, the same vehicle can be tested up to Mach 14. The HRV can be powered with either hydrocarbon or hydrogen scramjets. The HRV provides a near-term approach for obtaining hypersonic flight data and testing advanced systems under real flight conditions. Author

A93-25533*# National Aeronautics and Space Administration, Washington, DC.

PROPULSION/AIRFRAME INTEGRATION ISSUES FOR WAVERIDER AIRCRAFT

ISIAH M. BLANKSON (NASA, Washington) and PAUL HAGSETH (General Dynamics Corp., Fort Worth, TX) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0506) Copyright

While many propulsion concepts and technologies developed for nonwaverider-type hypersonic vehicles may apply to waveriders, some aspects of these configurations require unique technological approaches. An evaluation is made of such distinctive opportunities in the cases of engine cycle selection, inlets, nozzle designs and integration, longitudinal stability, and thermal management. Also discussed are waverider requirements for control surface effectiveness, inlet boundary layer ingestion effects, and structural/configurational optimization, giving attention to trades in volumetric/structural efficiency and vehicle L/D. O.C.

A93-27238

TACTICAL COCKPITS - THE COMING REVOLUTION

EUGENE C. ADAM (McDonnell Aircraft Co., Saint Louis, MO) In High-resolution displays and projection systems; Proceedings of the Meeting, San Jose, CA, Feb. 11, 12, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 58-65.

Copyright

Such advanced sensor- and image/signal processing-based technologies as helmet displays, large flat-panel displays, speech-command recognition, decision-aiding and stereopsis are simultaneously approaching maturity at the present time. Tactical aircraft cockpit systems which integrate these technologies are here envisioned, and their payoffs in pilot workload reduction and mission effectiveness enhancement are evaluated. Attention is given to 'agile eye' helmet visor-mounted HUDs, and 'big picture' cockpit and helmet displays that merge tactical and global situational awareness. O.C.

A93-27276

DESIGNED FOR WORK

HARRY HOPKINS Flight International (ISSN 0015-3710) vol. 142, no. 4348 Dec. 9, 1992 p. 30-34.

Copyright

The BAe Jetstream 41 29-seat regional airliner is a stretched-fuselage version of the J31 designed with a view to early entry into service and low purchase and operating costs. Two Garrett 1120 kW turboprops are used; cockpit instrumentation has been updated to employ CRT-based flight instruments. Performance capabilities and flight qualities of the aircraft are surveyed and compared with such representative market competitors as the Do 328 and EMB-120. O.C.

A93-27293

PROBLEMS IN THE MODELING OF HELICOPTER FLIGHT [PROBLEMY MODELOWANIA RUCHU SMIGLOWCA]

WIESLAW LUCJANEK (Politechnika Warszawska, Warsaw, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817) no. 103 1991 p. 145-148. In Polish.

The available physical and mathematical models used to describe the flight of a helicopter are reviewed. Some fundamental principles of helicopter flight modeling are briefly examined, as are some problems involved. V.L.

A93-27371

INVESTIGATION OF CABIN NOISE REDUCTION IN THE Y12

QI-HANG YAO, WEN-CHAO HUANG, and XIAO-JUN MA (Aircraft Strength Research Inst., Xian, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 4 Nov. 1992 p. 277-283. Translation. Previously cited in issue 02, p. 150. Accession no. A93-11816 refs

Copyright

A93-27375

A METHOD AND A SOFTWARE FOR CONSTRUCTING F-BY-F RANDOM LOAD SPECTRUM

JIAN LI and ZHI-WEI CHEN (Beijing Aeronautical Technology Research Center, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 4 Nov. 1992 p. 300-304. refs

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A method and software for computing flight-by-flight (F-by-F) random load spectrum are presented. The software uses load factors at the center of gravity of flying aircraft to create Markov matrices corresponding to each flight mission. A statistical average Markov matrix is adjusted to obtain an uninterrupted load sequence, and a sequence of half cycles is drawn from the matrix to construct an F-by-F random load spectrum. A sample application is given. C.D.

A93-27479

INTEGRATION OF HIGH BYPASS RATIO ENGINES ON MODERN TRANSONIC WINGS FOR REGIONAL AIRCRAFT

E. GREFF, K. BECKER, M. KARWIN, and S. RILL (Deutsche Airbus GmbH, Bremen, Germany) Aeronautical Journal (ISSN 0001-9240) vol. 97, no. 961 Jan. 1993 p. 1-13. refs

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Turbofan engine manufacturers have begun to deliver powerplant designs for 80-130 passenger, 1500-naut. mi. range regional airliners that are based on advanced-technology engine cores and long, concentric-exhaust mixing ducts for higher efficiency and reduced SFC. The installation of such long-duct nacelles underwing on such small aircraft may result in close-coupled interference phenomena; attention is accordingly given here to interference analysis methods. Design modifications for the nacelle/wing configuration's proportions have been devised and checked by means of a 3D Euler code and a wind tunnel halfspan model. O.C.

A93-27480

A GENERIC HARMONIC ROTOR MODEL FOR HELICOPTER FLIGHT SIMULATION

M. CHAIMOVICH, A. ROSEN, and O. RAND (Technion - Israel

Inst. of Technology, Haifa) Aeronautical Journal (ISSN 0001-9240) vol. 97, no. 961 Jan. 1993 p. 14-24. refs

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A new rotor model for helicopter flight mechanics simulation is presented. The rotor dynamics are described using multiblade coordinates, and the aerodynamic loads include nonlinear effects such as stall and compressibility. These loads are described as harmonic series. The number of harmonics in the series determines the model accuracy. Thus by changing the number of harmonics from one to a large number, it is possible to obtain models that range between a quasi-tip path plane approach and an accurate blade element model. The user of the model can very easily change the model accuracy and consequently its efficiency. The new rotor model is investigated and its application for trim and maneuver calculations is presented and discussed. Author

A93-27500

DORNIER 228 EXPERIMENTAL WITH LAMINAR WING

BERTUS MOEKEN, WERNER WOHLRATH, and KARL-HEIZ HORSTMANN Dornier Post (ISSN 0012-5563) no. 4 1992 p. 38, 39.

The German 'Laminar Wings' program based on laminar technology for commuter and commercial aircraft is described, with particular attention given to aircraft test equipment and flight test results. The performance of the laminar wing technology was tested using the DLR Dornier 228 test bed aircraft. It is noted that the projected savings in fuel are expected to be between 10 and 20 percent. O.G.

A93-27903

THE TILT WING ADVANTAGE - FOR HIGH-SPEED VSTOL AIRCRAFT

Aerospace Engineering (ISSN 0736-2536) vol. 13, no. 2 Feb. 1993 p. 9-13.

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Tilt wing aircraft and their vertical or short takeoff and landing applications are reviewed. It is concluded that the tilt wing concept for high-speed VSTOL aircraft has many advantages over helicopters and tilt rotor type aircraft which makes it a more efficient, cost effective, safer, and easier aircraft to operate. Particular attention is given to the CTW-409 tilt wing aircraft designed by William F. Chana associates and the TW-68 tilt wing aircraft which is being developed by Ishida Aerospace Research, Inc. O.G.

A93-27951

AHS NATIONAL TECHNICAL SPECIALISTS' MEETING ON ROTORCRAFT STRUCTURES, WILLIAMSBURG, VA, OCT. 29-31, 1991, PROCEEDINGS

Alexandria, VA American Helicopter Society 1991 446 p.

The present conference discusses structural reliability of fail-safe helicopter components, rotating load usage monitoring from fixed system information, the delamination behavior of graphite-epoxy laminates in tension and torsion, a two-point exponential approximation method for airframe optimization, a design and analysis methodology for composite bonded joints, low-vibration airframes, a damage tolerance processor for structural integrity management, and the effects of composite materials on the wing design of the V-22. Also discussed are advanced kevlar sandwich structures for application to rotorcraft airframes, the evolution of permanent composite repair designs, novel approaches to complex-geometry composite structures, and NASA-Langley techniques for helicopter airframe vibration reduction. (For individual items see A93-27952 to A93-27978) O.C.

A93-27952

A STRUCTURAL RELIABILITY EVALUATION OF FAIL-SAFE HELICOPTER DYNAMIC COMPONENTS

A. E. THOMPSON and D. O. ADAMS (Sikorsky Aircraft, Stratford, CT) In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 14 p. refs

An account is given of a reliability simulation analysis for fail-safe

components that are retired 'on condition' when damage is detected at a scheduled inspection. The two illustrative components are the UH-60A helicopter's servo beam rail and main rotor spindle thread mode. The analysis shows that the former, which is currently retired at 11,000 hrs, meets the 'six-nines' reliability requirement at 20,000 hrs. Also examined is the impact of degraded population strength on fail-safe reliability. O.C.

A93-27953**AH-64A ROTATING LOAD USAGE MONITORING FROM FIXED SYSTEM INFORMATION**

C. T. GUNSALLUS (Kaman Aerospace Corp., Bloomfield, CT) and ERIC ROBESON (U.S. Army, Aviation Systems Command, Fort Eustis, VA) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 11 p. refs (Contract DAAJ02-90-C-0013)

The ability of holometric flight load determination techniques to accurately determine rotating component loads using fixed system information is verified for the AH-64A helicopter. For this verification, recorded AH-64A flight load data is employed for holometric system calibration. Flight load data not used for the calibration is used to blind test the holometric method by comparing synthesized component load-time histories with their equivalent actual load-time histories. Comparisons of the synthesized and actual rotating component load-time histories are shown for a range of maneuvering and steady flight conditions. The comparisons show that detailed usage monitoring of AH-64A critical components is possible using holometrics. Author

A93-27954**LOAD VARIABILITY OF A TWO-BLADED HELICOPTER**

RAGHUPATI BOORLA (Bell Helicopter Textron, Inc., Fort Worth, TX) and KEVIN ROTENBERGER (U.S. Army, Aviation Systems Command, Saint Louis, MO) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 16 p. refs

A flight loads variability analysis program was conducted using the Bell Model OH-58C helicopter. A representative flight consisting of 33 maneuvers was repeated 30 times using six pilots (three from Bell Helicopter Textron and three from the Army) who flew the aircraft five times each. The resulting data was analyzed statistically to determine the parameters of distribution and variability using three different sets of data: peak loads, maneuver loads and total flight loads. In addition, the damage rates were also analyzed statistically. The results indicate that the maximum oscillatory loads exhibit a larger variability than that obtained by analyzing either maneuver loads or the flight loads and that the Weibull distribution can be used to represent the distribution shapes of both the maneuver and flight loads. Assessment of load variability on a total flight basis reduces the complexity of reliability computations. Author

A93-27956* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

APPLICATION OF A TWO-POINT EXPONENTIAL APPROXIMATION METHOD IN OPTIMIZING ROTORCRAFT AIRFRAME STRUCTURES

ASHISH K. SAREEN, GEORGES M. FADEL, and DANIEL P. SCHRAGE (Georgia Inst. of Technology, Atlanta) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 12 p. refs (Contract NAS1-18458)

The Fadel (1990) two-point exponential approximation technique for rotorcraft airframe structural optimization is presently examined by comparing its results with the well established linear and hybrid first-order methods. Attention is given to both the elastic-line and FEM models of an AH-1G airframe. The Direct Matrix Abstraction Programming Language is used to compute sensitivity derivatives

and motivate the CONMIN optimizer to produce the design change. O.C.

A93-27959**PROGRESS IN THE APPLICATION OF A NON-LINEAR PROGRAMMING METHODOLOGY TO THE DESIGN OF A LOW-VIBRATION AIRFRAME**

CHARLES F. NIEBANCK (Sikorsky Aircraft, Stratford, CT) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 9 p. refs

Computer algorithms are now available for altering helicopter airframe-design FEM models to better agree with the results of shake test response data. Attention is presently given to the Parameter Refinement for Dynamic Models, or 'PAREDYM', algorithm; airframe vibration conditions and locations are analyzed, and the most critical transfer coefficients are selected for improvement. Modal response functions are compared in order to focus the tuning process on the most important modes. O.C.

A93-27962**A DAMAGE TOLERANCE/LIFE PROCESSOR FOR STRUCTURAL INTEGRITY AND FORCE MANAGEMENT**

PRESTON R. BATES (Georgia Inst. of Technology, Atlanta) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 11 p. refs

Technical issues associated with the application of structural integrity criteria to helicopters and fixed-wing aircraft in a total system concept are discussed, giving attention to the use of the Helicopter Structural Integrity Program in the specific case of the MH-53J helicopter. A successful structural integrity program depends on both accurate analytical methods and the ground and flight test programs that furnish strain and material data. O.C.

A93-27963**A RETROSPECTIVE OF 3600 COMPOSITE BLADES**

C. P. HARDERSEN and P. F. MALONEY (Kaman Aerospace Corp., Bloomfield, CT) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 8 p. refs

The K747 composite main rotor blades manufactured since 1976 for the AH-1 Cobra helicopters have undergone numerous modifications and in-service accidents from which important lessons pertinent to blade structural design for impact survival and low maintenance can be based. Assessments are presently made of composite blade design, manufacturing, performance, and field operation criteria that have emerged in the course of K747 service. O.C.

A93-27964**THE EFFECTS OF COMPOSITE MATERIAL ON THE CONFIGURATION AND DESIGN OF THE V-22 WING**

E. E. SENN, JR. (Bell Helicopter Textron, Inc., Fort Worth, TX) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 6 p.

The unique capabilities of the V-22 tiltrotor aircraft generate stringent design conditions foreign to conventional rotorcraft. Strength, stiffness, and weight requirements dictate that the most efficient wing design is one that utilizes a carbon/epoxy composite to the fullest extent. Since the raw material and fabrication costs of composite components are generally higher than those of a typical aluminum structure, the designers were faced with a tremendous challenge to provide carbon/epoxy components within producibility and cost guidelines. This paper is a description of the V-22 wing torque box structure and the design conditions that generate the functional and structural requirements. Author

A93-27966

REPAIR OF A SEVERELY DAMAGED COMPOSITE FUEL POD

A. H. MAGISO (Boeing Defense & Space Group, Philadelphia, PA) *In* AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 26 p.

An account is given of the technical aspects of repair for the composite sandwich panel structure fuel pod of a Boeing 234 passenger helicopter; the repair process was conducted entirely at room temperature and with minimal tooling and composite-specific skills. The sandwich structure involves 1.5-inch thick nomex honeycomb cores and symmetrical hybrid kevlar 49/HMS graphite laminate face-plates. Attention is given to laminate repair layouts. O.C.

A93-27967

EVOLUTION OF PERMANENT COMPOSITE REPAIR DESIGNS

D. A. REISDORFER (Bell Helicopter Textron, Inc., Fort Worth, TX) *In* AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 10 p.

This paper emphasizes the challenges in composite repair by presenting two repair concepts developed under the V-22 Composite Repair Development program. These two concepts represents repair designs of high-strain structure and of stability-critical structure. A general description of the repair design process, the design drivers, and repair issues associated with each design concept is provided. The paper highlights the different philosophy between repairs of high-strain structure and stability-critical structure. The results of finite-element analysis and design support tests are presented for each type of repair. The importance of concurrent engineering (consisting of design engineering specialists, logistics engineers, and government repair specialists) on the final repair design is also discussed. Lessons learned and specific problem areas associated with each concept are emphasized. Author

A93-27971 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM - ACCOMPLISHMENTS AND CONTRIBUTIONS

RAYMOND G. KVATERNIK (NASA, Langley Research Center, Hampton, VA) *In* AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 35 p. Previously announced in STAR as N92-17034 refs

(Contract RTOP 505-63-36-01)

A NASA Langley-sponsored rotorcraft structural dynamics program, known as Design Analysis Methods for VibrationS (DAMVIBS), has been under development since 1984. The objective of this program was to establish the technology base needed by the industry to develop an advanced finite-element-based dynamics design analysis capability for vibrations. Under the program, teams from the four major helicopter manufacturers have formed finite-element models, conducted ground vibration tests, made test/analysis comparisons of both metal and composite airframes, performed 'difficult components' studies on airframes to identify components which need more complete finite-element representation for improved correlation, and evaluated industry codes for computing coupled rotor-airframe vibrations. Studies aimed at establishing the role that structural optimization can play in airframe vibrations design work have also been initiated. Five government/industry meetings were held in connection with these activities during the course of the program. Because the DAMVIBS Program is coming to an end, the fifth meeting included a brief assessment of the program and its benefits to the industry. Author

A93-27972 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EXPERIENCES AT LANGLEY RESEARCH CENTER IN THE APPLICATION OF OPTIMIZATION TECHNIQUES TO HELICOPTER AIRFRAMES FOR VIBRATION REDUCTION

T. SREEKANTA MURTHY (Lockheed Engineering & Sciences Co., Hampton, VA) and RAYMOND G. KVATERNIK (NASA, Langley Research Center, Hampton, VA) *In* AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. Previously announced in STAR as N92-17033 refs

(Contract RTOP 505-63-36-01)

A NASA/industry rotorcraft structural dynamics program known as Design Analysis Methods for VibrationS (DAMVIBS) was initiated at Langley Research Center in 1984 with the objective of establishing the technology base needed by the industry for developing an advanced finite-element-based vibrations design analysis capability for airframe structures. As a part of the in-house activities contributing to that program, a study was undertaken to investigate the use of formal, nonlinear programming-based, numerical optimization techniques for airframe vibrations design work. Considerable progress has been made in connection with that study since its inception in 1985. This paper presents a unified summary of the experiences and results of that study. The formulation and solution of airframe optimization problems are discussed. Particular attention is given to describing the implementation of a new computational procedure based on MSC/NASTRAN and CONstrained function MINimization (CONMIN) in a computer program system called DYNOPT for the optimization of airframes subject to strength, frequency, dynamic response, and fatigue constraints. The results from the application of the DYNOPT program to the Bell AH-1G helicopter are presented and discussed. Author

A93-27974

ADVANCED COMPOSITE HELICOPTER MISERS GOLD TEST/ANALYSIS

MARY A. PARTRIDGE, MICHAEL L. ATKINSON, LAWRENCE J. MENTE (Kaman Sciences Corp., Aviodyne Div., Burlington, MA), and KELLIE B. UNSWORTH (U.S. Army, Aviation Systems Command, Fort Eustis, VA) *In* AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 14 p. refs

The U.S. Army's D292 composite helicopter participated in the MISERS GOLD high-explosive simulation of nuclear blast effects. Both the primary and secondary structures of the D292 involve combinations of kevlar/epoxy, kevlar-graphite/epoxy hybrids, and glass fiber/epoxy. Accounts are presently given of the vehicle, the test rationale, the data types collected, posttest aircraft damage, and the methodology of the posttest analytical data correlation efforts. O.C.

A93-28602

REGIONAL FANJET AIRCRAFT OPTIMIZATION STUDIES

LLOYD R. JENKINSON (Loughborough Univ. of Technology, United Kingdom) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 168-177. Previously cited in issue 23, p. 4014, Accession no. A91-54013 Research sponsored by Short Brothers, PLC refs

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A93-28612* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

CONCEPTUAL ASSESSMENT OF TWO HIGH-SPEED ROTORCRAFT

JOHN W. RUTHERFORD, MATTHEW J. O'ROURKE, MARC A. LOVENGUTH, and CLARK A. MITCHELL (McDonnell Douglas Helicopter Co., Mesa, AZ) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 241-247. refs

(Contract NAS2-13070)

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Recently completed high-speed rotorcraft design studies for NASA provide the basis to assess technology needs for the development of these aircraft. Preliminary analysis of several concepts possessing helicopter-like hover characteristics and cruise capabilities in the 450-kt regime, led to the selection of two concepts for further study. The concepts selected included the rotor/wing and the tilt wing. Designs, based on current technology for each, established a baseline configuration from which technology trade studies could be conducted. Technology anticipated to be ready for application in the year 2005 set the goals for the trade studies. An assessment of the technologies' impact on the effectiveness of the concept served as the basis to determine potential risk, payoff, and criticality. Advanced technology, applied to either of these concepts, significantly improves the effectiveness and the attributes of the concepts.

Author

A93-29241

MODAL ANALYSIS IN THE CERTIFICATION OF A COMMERCIAL AIRCRAFT

W. R. BUCKLEY (Boeing Canada, De Havilland Div., Downsview) and J. B. POLAND (LMTS Corp., Huntington Beach, CA) *In* International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 1 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 158-164. refs Copyright

This paper discusses the application of an integrated modal analysis package to the certification of a FAR 25 transport category aircraft - the Boeing Canada, de Havilland Division Dash 8 Series 300A. The GVT was performed under subcontract by LMTS North America in eight days on the test article, followed by completion of the modal analysis. At this point the finite element model of the structure was correlated with the GVT modal data, and brought into agreement, using the LMS LINK package. This process took three weeks. Having the updated FEA model, the flutter analysis required for certification of the aircraft was undertaken. The tight schedule, from availability of the vehicle for the GVT to the commencement of flight flutter testing, required the use of a seamless package of programs which handled the modal information in a consistent user friendly format. This paper discusses the test setup, instrumentation, the modal software used and the correlation process.

Author

A93-29246

GROUND VIBRATION TEST ON PIAGGIO P. 180 AIRCRAFT - COMPARISON BETWEEN TWO MODAL TEST METHODS

PAOLO CHIARLONE (Rinaldo Piaggio S.p.A., Finale Ligure, Italy) and CECILIA SURACE (Torino, Politecnico, Turin, Italy) *In* International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 1 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 239-245. Research supported by CNR refs Copyright

A comparison is made between a phase resonance test and a phase separation test on the structure of a complete Piaggio P. 180 aircraft. The test methods are described along with the equipment, including the means of excitation, the response measurement equipment, and the aircraft suspension system. The advantages and drawbacks of the two methods are discussed.

C.D.

A93-29267

APPLICATION OF FEM MODEL CORRELATION AND UPDATING TECHNIQUES ON AN AIRCRAFT USING TEST DATA OF A GROUND VIBRATION SURVEY

M. BRUGHMANS, J. LEURIDAN (LMS International, Louvain, Belgium), G. HRYCKO, and J. WYZKOWSKI (Boeing Canada, De Havilland Div., Downsview) *In* International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 1 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 517-525. refs Copyright

The paper discusses the application of a FEM model updating

technique, based on a forward sensitivity formulation, to a twin propeller commuter aircraft. The applied updating technique varies the mass and stiffness characteristics of the FEM model so that predicted system performance, in terms of modal parameters, matches the measured system performance from a Ground Vibration Test. The variations of the mass and stiffness characteristics are realized by proportional changes of the FEM element mass and stiffness matrices, thereby disturbing the original structure of the FEM model as little as possible. Proportional changes of groups of elements can be linked in one variable, and interpreted in terms of variations in corresponding element material or geometry characteristics. The model updating technique is applied to improve the dynamic model of a BOEING DeHavilland DASH8-300A aircraft based on data from a Ground Vibration Test. A correlation analysis followed by FEM updating resulted in a closer fit of the analytical and experimental modal parameters. The different steps in this updating procedure, leading to a more reliable model for further analytical flutter analysis, are discussed in detail.

Author

A93-29414 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A COMPARATIVE ANALYSIS OF XV-15 TILTROTOR HOVER TEST DATA AND WOPWOP PREDICTIONS INCORPORATING THE FOUNTAIN EFFECT

CHARLES K. RUTLEDGE (Lockheed Engineering and Sciences Co., Hampton, VA), CHARLES D. COFFEN, and ALBERT R. GEORGE (Cornell Univ., Ithaca, NY) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 20 p. Research sponsored by NASA refs (Contract NAG2-554) Copyright

Acoustic measurements from a hovering full-scale XV-15 tiltrotor with the advanced technology blades are presented which show the directionality of fountain effect noise. Predicted activity directivity results are also presented which show agreement with the measured data. The aeroacoustic code, WOPWOP, was used in conjunction with a mathematical model which simulated the fountain/recirculation aerodynamic effect on the rotors' blade surface pressures. The predictions were used to identify the spike character in the measured data as fountain effect associated noise. The directivity of the fountain effect noise was observed to be dominant at the rear of the aircraft with increased intensities 45 degrees below the rotor disk planes.

Author

A93-29421

TILTROTOR INTERIOR NOISE CHARACTERISTICS

SUZANNA S. SHANK (Bell Helicopter Textron, Inc., Fort Worth, TX) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 16 p. refs Copyright

Noise measurement surveys have been conducted aboard the XV-15 to ascertain a tilt-rotor aircraft's noise sources, as well as their frequencies, amplitude levels, and spatial distributions throughout the cabin. Comparisons are presently made with the internal noise characteristics of other aircraft types, with a view to prospective improvements that must be made in tiltrotor aircraft before full acceptability of cabin noise levels to passengers is achieved.

O.C.

A93-29439

UNSTEADY WAKE EFFECT ON ROTOR VIBRATORY AIRLOADINGS

KYUNG M. YOO (Korea Inst. of Aeronautical Technology, Seoul, Republic of Korea) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 14 p.

refs

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The azimuthal variations in the downwash distribution of a rotor in hover induce blade bending vibrations. The magnitude of unsteady aerodynamic damping is quite important in determining these vibration levels because these effects involve resonances between the harmonics of steady airloading distribution and the natural frequencies of the rotating blades. The present work is aimed at investigating the unsteady wake effect on abrupt lift loss of hovering rotor undergoing various hub cyclic motions and on aerodynamic damping loss of elastic blade-flapping motions in hover by time-marching numerical procedure designed for simulating interactive phenomena between rotor blades and their shed wake using unsteady vortex lattice method along with time-dependent strength of vortices traveling in prescribed wake geometries. The perturbed time histories of the resulting airloads and blade motions in hovering rotor demonstrate the unsteady wake effect of near and returning wake between a preceding and a reference blade including successive revolutions. This work suggests an alternative way of rotor aeroelastic stability analysis using elastic lifting surface aerodynamics without excessive computational cost.

Author

N93-19447# Army Lab. Command, Watertown, MA. Material Technology Lab.

ASSESSMENT OF HELICOPTER COMPONENT STATISTICAL RELIABILITY COMPUTATIONS Final Report

WILLIAM T. MATTHEWS and DONALD M. NEAL Sep. 1992 28 p (AD-A258931; MTL-TR-92-71) Avail: CASI HC A03/MF A01

This report identifies potential errors in computing high statistical reliability for a required component fatigue life. The reliability values were determined from application of a joint probability density (JPD) analysis used in an American Helicopter Society round robin safe life problem. In the analysis normal probability density functions (PDF's) were assumed for both the material strength and the spectrum load values. The PDF model parameters were varied and the PDF's were slightly modified (contaminated) in order to examine the sensitivity in computing high statistical reliability when uncertainties exist in assuming the PDF. Lower tails of the PDF's were also modified by truncation, independent of the model contamination, in order to determine the relative influence on reliability from tail modifications as compared with the parameter uncertainties and contamination. The stability of statistical estimates of the extreme tail quantiles and their corresponding probabilities as a function of sample size were examined for a generic distribution. Assuming a PDF to represent load or material strength is a substantially more critical issue than accurate representation of the extreme lower tail of the PDF when computing high reliability. Sampling trials for extreme tail quantiles and reliabilities indicate that unstable values can result from sample sizes of 100. The primary conclusion from these analytic results is that the computation of a high statistical reliability may have little or no association with actual engineering high reliability.

GRA

N93-19460*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. Center for Aerospace Research.

LUMPED MASS MODELLING FOR THE DYNAMIC ANALYSIS OF AIRCRAFT STRUCTURES

ELIAS G. ABU-SABA (North Carolina Agricultural and Technical State Univ., Greensboro.), JI YAO SHEN (North Carolina Agricultural and Technical State Univ., Greensboro.), WILLIAM M. MCGINLEY (North Carolina Agricultural and Technical State Univ., Greensboro.), and RAYMOND C. MONTGOMERY In North Carolina Agricultural and Technical State Univ., The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 10 p 12 Dec. 1992 Submitted for publication Avail: CASI HC A02/MF A03

Aircraft structures may be modelled by lumping the masses at particular strategic points and the flexibility or stiffness of the

structure is obtained with reference to these points. Equivalent moments of inertia for the section at these positions are determined. The lumped masses are calculated based on the assumption that each point will represent the mass spread on one half of the space on each side. Then these parameters are used in the differential equation of motion and the eigen characteristics are determined. A comparison is made with results obtained by other established methods. The lumped mass approach in the dynamic analysis of complicated structures provides an easier means of predicting the dynamic characteristics of these structures. It involves less computer time and avoids computational errors that are inherent in the numerical solution of complicated systems.

Author

N93-19849# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

A SIMULATION STUDY ON TAKE-OFF AND LANDING DYNAMICS OF THE AIRCRAFT OF A FLY-BY-WIRE CONTROL SYSTEM

YACHANG FENG, GANG CHEN, and PEIQIONG LI 7 Jan. 1993 21 p Transl. into ENGLISH from Hangkong Xuebao (China), v. 12, no. 6, Jun. 1991 p 252-258 (AD-A259286; FASTC-ID(RS)T-0313-92) Avail: CASI HC A03/MF A01

Based on the dynamic theory of rigid body systems and combined with the flying kinetic characteristics of aircraft during take-off and landing, a 6-degree of freedom aircraft equation for a rigid body system formed by the landing gear-aircraft fuselage is formulated. The pilot time-domain mathematical models for the step-target tracking was proposed, and these models will help evaluate the flying qualities of the pilot/vehicle system during take-off and landing. Then the mechanical control system and the mathematical models for the control-by-wire system are established. The total time-domain simulation procedure of the non-wire type is worked out to provide a complete quantitative analysis of the dynamic qualities in take-off and landing of aircraft, and the results agree well with the flight test data.

GRA

N93-19901# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

FLIGHT TESTING [LES ESSAIS EN VOL]

Oct. 1992 405 p In ENGLISH and FRENCH Symposium held in Chania, Greece, 11-14 May 1992 (AGARD-CP-519; ISBN-92-835-0688-X) Copyright Avail: CASI HC A18/MF A04

It is considered by the Flight Mechanics Panel of AGARD as vitally important that the NATO flight test community meet regularly so that new techniques for flight test, instrumentation and data analysis and lessons learned from past and on-going programs be disseminated to ensure that safe efficient cost-effective and timely testing is accomplished. There are many new systems being tested or planned for testing in the near future. These include programmable signal processor radars, integrated flight, fire and propulsion control systems, thrust vectoring, low observable technologies, multifunction pilot displays and multisensor integration. Acquisition and processing of large quantities of avionics multiplex data are challenges that must be met. There is a need for greater use of simulators and other hardware-in-the-loop ground test facilities.

N93-19903# Aerospatiale, Toulouse (France).

FLIGHT TESTS OF THE TRANSPORT AIRCRAFT VIEWED FROM THE INDUSTRIAL STANDPOINT [LES ESSAIS EN VOL DES AVIONS DE TRANSPORT VUS SOUS LA PERSPECTIVE INDUSTRIELLE]

G. DEFER and G. DESTARAC In AGARD, Flight Testing 6 p Oct. 1992 In FRENCH

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The development of new aircraft requires very heavy investments. Among these investments are the flight tests. Even if the flight tests correspond, on the average of 8 percent of the development cost, an economical approach should be taken. This

is what Aerospatiale tried to do for nearly 3 decades on the main base of Toulouse Muret. The present development situation is described. Author

N93-19904*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

LESSONS LEARNED FROM AN HISTORICAL LOOK AT FLIGHT TESTING

SETH B. ANDERSON /in AGARD, Flight Testing 11 p Oct. 1992

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A brief historical review of accidents was made to examine lessons learned in flight testing with major emphasis on human factors limitations. The results of this survey show undeniably that new aircraft and new pilots are not immune to old problems. Of three related human factors limitations, pilot skill frequently showed up as the primary factor responsible for accidents due to inadequate training (or proficiency) to handle an unexpected situation. A primary contributing factor was unsatisfactory aircraft handling qualities which increased pilot work load and therefore were less forgiving to 'pilot error,' particularly when flown in a stressful situation at the extremes of the flight envelope. Historically, pilot induced oscillation (PIO) has persisted as a major control problem particularly in first-flight operation. Deliberate errors involving a conscious decision to 'take a chance' by flying an aircraft with known deficiencies occurred more frequently in early times. Finally, inadvertent errors involving forgetfulness, indecision, and confusion are occurring more frequently with the current trend toward automated computerized controlled cockpits. Author

N93-19906# Lockheed Advanced Development Co., Sunnyvale, CA.

YF-22A PROTOTYPE ADVANCED TACTICAL FIGHTER DEMONSTRATION/VALIDATION FLIGHT TEST PROGRAM OVERVIEW

RICHARD ABRAMS /in AGARD, Flight Testing 21 p Oct. 1992
Copyright Avail: CASI HC A03/MF A04

The Lockheed Aeronautical Systems Company, teamed with the General Dynamics Fort Worth Division and Boeing Military Airplanes Company, designed, built and flight tested two YF-22A Advanced Tactical Fighter (ATF) prototypes which were powered by new prototype high thrust-to-weight ratio engines. The YF-22A design optimized the blend of low observability, maneuverability and supersonic performance. These design goals were achieved with the incorporation of many new and innovative technologies including thrust vectoring, integrated flight and propulsion control, internal weapons carriage, and composite materials. An advanced cockpit with colored liquid crystal displays, finger-on-glass controls and advanced avionics architecture was also incorporated in the prototypes. The YF-22A Demonstration/Validation (Dem/Val) flight test program was completed on the 28th of December 1990. Seventy-four flights for a total of 91.6 flight hours were accumulated on both prototypes. The first flight of YF-22A No. 1 was made on 29 September 1990, the second prototype flew on 30 October 1990. The primary objective of the Dem/Val flight test program was to demonstrate the airplane's capabilities. This approach, which prioritized the use of the aircraft as demonstrators over their use as development tools, was considered to be the most efficient method of generating the test data required for the Engineering and Manufacturing Development (EMD) proposal. The purpose of this paper is to briefly describe some of the YF-22A's unique design features and the Dem/Val flight test program. Author

N93-19908# National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH.

THE NATIONAL AERO-SPACE PLANE PROGRAM: A REVOLUTIONARY CONCEPT

ROBERT R. BARTHELEMY /in AGARD, Flight Testing 9 p Oct. 1992

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NASP - The National Aero-Space Plane - is a look into the future. It is a vision of the ultimate airplane, one capable of flying at speeds greater than 17,000 miles per hour, 25 times the speed

of sound. It is the attainment of a vehicle that can routinely fly from earth to space and back, from conventional airfields, in affordable ways. It is the achievement of major technological breakthroughs that will have an enormous impact on the future growth of this nation. Most of all, it is a projection of America at its best, at its boldest, at its most creative. NASP is more than a national aircraft development program, more than the synergy of revolutionary technologies, more than a capability that may change the way we move through the world and the aerospace around it. NASP is a revolutionary technical, managerial, and programmatic concept; it is a possibility of what can be in America. The NASP program can be described in a number of ways: technological, programmatic, utilitarian, and conceptual. In each case, NASP has departed from the traditional evolutionary path. In order to achieve the vision of NASP, innovative and revolutionary approaches are required. The technical challenges require the synergism of several major technology breakthroughs. The programmatic challenges require a fundamental change in the development, management, and implementation of this strategic, high-tech program. The utility challenge requires a transformation of our thinking about aeronautical and aerospace systems. The conceptual challenge requires a paradigm shift in national planning, collaboration, and commitment. Each of these challenges, and the NASP response to them, is explored in the following pages. Author

N93-19909# Army Aviation Systems Command, Moffett Field, CA.

GENERATION OF HELICOPTER ROLL AXIS BANDWIDTH DATA THROUGH GROUND-BASED AND IN-FLIGHT SIMULATION

HEINZ-JUERGEN PAUSDER (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin, Germany) and CHRIS L. BLANKEN /in AGARD, Flight Testing 15 p Oct. 1992

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N93-19910# Alenia, Torino (Italy).

AM-X HIGH ANGLE OF ATTACK FLIGHT TEST EXPERIENCE (SINGLE AND TWO SEAT VERSIONS)

G. MENSO, B. MARCHETTO, and E. MONFORTE /in AGARD, Flight Testing 13 p Oct. 1992

Copyright Avail: CASI HC A03/MF A04

This paper describes the activities carried out at the ALENIA Flight Test Center in order to investigate the high angle of attack characteristics of the AM-X. Before starting with the flight tests, vertical wind tunnel and rotary balance facilities have been used to collect all the information on aircraft behavior at stall, behind stall and in developed spin, in order to efficiently and safely approach the flight test activity. Flight tests have been tailored for the primary role of this A/C: the ground attack. Flight trails were firstly devoted to the combat configuration to assess the A/C capability to perform safe defensive maneuvers at high angle of attack. Then, a number of external stores key-configurations were tested to verify the A/C capability to safely perform vigorous maneuvers as required for such a light attack aircraft. Finally the twin seater behavior, clean and with stores, has been investigated. Analysis of the tests results provided the confidence for further investigating on developed spin characteristics and for the A/C qualification to intentional departure in a defined envelope for training purposes. Author

N93-19911# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).

X-31A HIGH ANGLE OF ATTACK AND INITIAL POST STALL FLIGHT TESTING

P. HUBER and H. GALLEITHNER /in AGARD, Flight Testing 11 p Oct. 1992

Copyright Avail: CASI HC A03/MF A04

In November 1991 after about one year of successful conventional flight testing, the X-31A research aircraft-no. 2 was taken to more than 30 degrees angle of attack for the first time. Since then a maximum angle of attack of about 53 degrees in 1-g flight has been achieved. This is the first time a dedicated post stall aircraft design has entered flight test beyond stall angles

of attack. This paper summarizes descriptions of the control law characteristics of the X-31A and describes the flight test approach followed to safely expand and explore the high angle of attack and post stall flight regime. Furthermore, preliminary handling qualities test results obtained from the initial post stall envelope expansion are presented. Author

N93-19912# Dassault-Breguet Aviation, Saint Cloud (France).
METHOD FOR DEVELOPING THE RAFALE FLIGHT CONTROL SYSTEM [METHODE DE DEVELOPPEMENT DU SYSTEME DE CONTROLE DU VOL DU RAFALE]

P. BOURDAIS and R. L. DURAND /In AGARD, Flight Testing 13 p Oct. 1992 In FRENCH

Copyright Avail: CASI HC A03/MF A04

The sequences are presented of the different tasks implemented for the development of the RAFALE SCV (Flight Control Program), and its design for its flight qualification, by giving details in particular of the essential points, namely the activities associated with the aerodynamic and structural modeling of the aircraft. The functional studies aim at defining the control laws, validating the SCV and its equipment in a real time flight controlled simulation environment, analyzing and processing the flight tests and incorporating these results in the adjustment phase of the SCV. Author

N93-19913# Instituto Superior Tecnico, Lisbon (Portugal).
ON AUTOMATED ANALYSIS OF FLIGHT TEST DATA

L. M. B. C. CAMPOS (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany), A. A. FONSECA, and A. M. G. CARDOSO (Portuguese Air Force Academy, Granja do Marques.) /In AGARD, Flight Testing 17 p Oct. 1992

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The automated analysis of flight test data depends on an indicator of when an atmospheric event, or flight maneuver, starts and ends. We use as indicator the disturbance intensity, which is defined as the relative lift change, and can be related either to aerodynamic or flight dynamical parameters. A number of flight test data records, obtained using the Portuguese CASA 212 Aviocar flight test aircraft, are analyzed to show how the start and end of a maneuver are signaled by the disturbance intensity. The latter is a possible objective measure, for a proposed scale of passenger/crew comfort, somewhat analogous to the Cooper-Harper handling qualities scale. Author

N93-19914# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin (Germany).
SYSTEM IDENTIFICATION FOR X-31A PROJECT SUPPORT: LESSONS LEARNED SO FAR

S. WEISS, E. PLAETSCHKE, D. ROHLF, and H. GALLEITHNER (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany) /In AGARD, Flight Testing 11 p Oct. 1992

Copyright Avail: CASI HC A03/MF A04

Flight testing of the X-31A post-stall experimental aircraft started in October 1990. Within the international 'Combined X-31A Flight Test Team', DLR contributes its system identification experience and capabilities for the determination of aerodynamic parameters from flight test data. The paper presents a brief description of the hard- and software for flight test data evaluation applied by DLR to support the X-31A project on-site. It describes the different steps of the data reduction and the models used for system identification. Selected results which were achieved mainly on the basis of data from flight test conducted for handling qualities investigations are shown and compared to wind tunnel predictions. The paper discusses the aspects of on-site system identification for flight test support, including the difficulties arising from working on a low-cost program. It is based on the experience made during the initial envelope expansion of the X-31A. Author

N93-19916*# National Aeronautics and Space Administration.
 Hugh L. Dryden Flight Research Facility, Edwards, CA.

OVERVIEW OF THE NASA DRYDEN FLIGHT RESEARCH FACILITY AERONAUTICAL FLIGHT PROJECTS TESTING

ROBERT R. MEYER, JR. /In AGARD, Flight Testing 17 p Oct. 1992

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Several principal aeronautics flight projects of the NASA Dryden Flight Research Facility are discussed. Key vehicle technology areas from a wide range of flight vehicles are highlighted. These areas include flight research data obtained for ground facility and computation correlation, applied research in areas not well suited to ground facilities (wind tunnels), and concept demonstration. Author

N93-19928# Kaman Aerospace Corp., Bloomfield, CT.
AN IMPROVED METHOD OF STRUCTURAL DYNAMIC TEST DESIGN FOR GROUND FLYING AND ITS APPLICATION TO THE SH-2F AND SH-2G HELICOPTERS

C. A. TOMASHOFSKI, E. J. NAGY, and P. E. KEARY /In AGARD, Flight Testing 23 p Oct. 1992

Copyright Avail: CASI HC A03/MF A04

An improved method of structural dynamic test design was developed at Kaman Aerospace Corporation over the past several years. The method, Generalized Force Determination or GFD, grew from experience using basic force determination during the early 1980's. Basic force determination was found to work extremely well for many types of fatigue test setups with limited matching criteria. In other tests, it was found that certain combinations of actuators and matching criteria would render the test rig impossible to calibrate. Basic force determination could not be used for those cases. Since then, the source of the difficulty has been identified, and fundamental theoretic foundations have been built by William G. Flannely (of Kaman Aerospace Corp.) to generalize the process of force determination for essentially any type of fatigue test arrangement. In addition, GFD has grown into a complete, automated, turn-key software package which guides the test engineer to the best possible solution within the constraints of the available test hardware and provides concrete insight into ways of adapting the hardware arrangement to improve the solution even further. The theoretical foundations are presented in broad outline in this paper. The fatigue tests done on full scale SH-2 helicopters which verified the practical applicability of GFD are described also. The steps in the complete GFD system were honed by the practical knowledge gained during the conduct of these tests. Author

N93-19929# Technische Hogeschool, Delft (Netherlands).
ON-LINE AIRCRAFT STATE AND PARAMETER ESTIMATION

M. LABAN /In AGARD, Flight Testing 23 p Oct. 1992

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Detailed mathematical models of aircraft aerodynamics find their use in aircraft design evaluation, flight simulation, control system tuning, and aircraft certification. Unknown parameters in these models can be extracted from flight test data by means of a variety of system identification techniques. This paper shows how on-line aerodynamic model identification has become feasible by applying algorithms based on a decomposition of the state and parameter estimation problem and the application of a high speed multi-processor computer system. Results from a recent flight test program are presented. Author

N93-19930# National Research Council of Canada, Ottawa (Ontario).
THE FLIGHT TEST AND DATA ANALYSIS PROGRAM FOR THE DEVELOPMENT OF A BOEING/DE HAVILLAND DASH 8 SIMULATOR MODEL

STEWART W. BAILLIE, KEN HUI, and JAAP DELEEUEW (AERCOL, Downsview, Ontario) /In AGARD, Flight Testing 19 p Oct. 1992

Copyright Avail: CASI HC A03/MF A04

A joint program between CAE Electronics Ltd., Montreal, and the Flight Research Laboratory, NRC, was conducted to develop high fidelity simulator models of the Dash 8 Series 100 and 300 aircraft. This paper focuses primarily on the Series 100 program. The flight test portion of the program entailed a relatively limited set of instrumentation due to aircraft ownership and regulatory

constraints. The primary measurements were the basic inertial quantities and flight path reconstruction techniques were used to generate the time histories of other required flight path parameters (such as angle of attack and sideslip). The major portion of flight test data was analyzed using Maximum Likelihood Estimation with reliance on trim condition data for initial model estimates. The final simulator model was validated using specifically designated maneuvers conducted solely for validation purposes. Author

N93-20245# General Accounting Office, Washington, DC. National Security and International Affairs Div.
REPORT TO THE CHAIRMAN, LEGISLATION, AND NATIONAL SECURITY SUBCOMMITTEE, COMMITTEE ON GOVERNMENT OPERATIONS, HOUSE OF REPRESENTATIVES. UNMANNED AERIAL VEHICLES: MORE TESTING NEEDED BEFORE PRODUCTION OF SHORT-RANGE SYSTEM
 Sep. 1992 14 p
 (AD-A259473; GAO/NSIAD-92-311) Avail: CASI HC A03/MF A01

The Short-Range Unmanned Aerial Vehicle (UAV) program is reviewed to determine whether it represents a valid joint-service effort that will minimize duplication among UAV programs and whether test results justify the imminent commitment to system production. The system's readiness for production is discussed. The in-depth evaluation is expected to be completed early next year and will focus on the detailed results of system testing as well as the joint-service aspects of the program. GRA

N93-20560# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AN INVESTIGATION OF DISCOVERY-BASED LEARNING IN THE ROUTE PLANNING DOMAIN M.S. Thesis
 FREEMAN A. KILPATRICK, JR. Dec. 1992 148 p
 (AD-A259141; AFIT/GCE/ENG/92D-07) Avail: CASI HC A07/MF A02

This thesis presents MAVERICK, a Discovery-Based Learning (DBL) system designed to learn maneuvers in the route planning domain. DBL was originally designed to learn in domains for which little domain knowledge exists. This thesis proposes using it in domains for which knowledge exists, but the acquisition of this knowledge is difficult or time-consuming because of the knowledge acquisition bottleneck. The operation of the DBL process in MAVERICK was investigated to determine the potential utility of such a system to a real-world Air Force problem in the domain of aircraft route planning. MAVERICK worked well in its limited domain, and demonstrated several positive aspects of the DBL process, specifically robustness, flexibility, and graceful degradation. Some negative aspects of the process were also encountered during this research; MAVERICK demonstrated a pronounced tendency towards unpredictability, both in its operation and its development. This likely precludes DBL from application to critical systems, however the positive aspects suggest DBL can have potential utility to other systems. GRA

N93-20575# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
THE INFLUENCE OF STRUCTURAL OPTIMIZATION ON THE AEROELASTIC PROPERTIES OF A VERTICAL TAIL M.S. Thesis
 DAVID G. MILLER Dec. 1992 149 p
 (AD-A259140; AFIT/GAE/ENY/92D-24) Avail: CASI HC A07/MF A02

The purpose of this thesis is to investigate the influence of structural optimization parameters on the structural and aeroelastic behavior of a vertical tail. The outside geometry of the tail is assumed to be fixed. The objective of the optimization is to reduce the structural member sizes so that the overall weight of the tail is minimized. The influence that design loads, design constraints, and design variable linking have on the optimal design is observed by examining several design cases. The static aeroelastic properties and flutter speeds of the various design cases are then compared. The doublet lattice method is used to calculate the steady and

unsteady subsonic aerodynamic loads and finite element theory is used to model the vertical tail structure. GRA

N93-20579# PPG Industries, Inc., Huntsville, AL. Aircraft Products Div.
T-38 FORWARD WINDSHIELD DEVELOPMENT AND PERFORMANCE DEMONSTRATION REPORT Final Report, Jun. 1982 - Sep. 1989

JAMES W. MYERS 12 Mar. 1992 298 p
 (Contract F33615-81-C-3403)
 (AD-A259240; WL-TR-91-3112) Avail: CASI HC A13/MF A03
 According to Air Force information, approximately 500 bird strikes occur each year in Air Training Command (ATC), with over half of these on the T-38. The current windscreen provides some protection at the slower speeds flown during the final phases of the T-38 landing pattern. However, during climbs, cruise, and descents below 10,000-feet the T-38 is normally flown at speeds of 240-to-300 knots which presents a bird strike hazard by larger birds to the pilots. The T-38 low level missions are of particular concern because they are flown at speeds of up to 420-knots. Based on training requirements, the altitude for T-38 low-level missions has decreased to 500-feet above ground level, along with increasing the number of sorties required. Although the Air Force plans student load reductions, the relative number of high-speed, low-level navigation sorties will increase. GRA

N93-20584*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF FLUTTER SUPPRESSION BY PIEZOELECTRIC ACTUATION
 JENNIFER HEEG Washington Mar. 1993 47 p
 (Contract RTOP 505-63-50-15)
 (NASA-TP-3241; L-17024; NAS 1.60:3241) Avail: CASI HC A03/MF A01

The objective of this research was to analytically and experimentally study the capabilities of piezoelectric plate actuators for suppressing flutter. Piezoelectric materials are characterized by their ability to produce voltage when subjected to a mechanical strain. The converse piezoelectric effect can be utilized to actuate a structure by applying a voltage. For this investigation, a two-degree-of-freedom wind tunnel model was designed, analyzed, and tested. The model consisted of a rigid wing and a flexible mount system that permitted a translational and a rotational degree of freedom. The model was designed such that flutter was encountered within the testing envelope of the wind tunnel. Actuators made of piezoelectric material were affixed to leaf springs of the mount system. Command signals, applied to the piezoelectric actuators, exerted control over the damping and stiffness properties. A mathematical aeroservoelastic model was constructed by using finite element methods, laminated plate theory, and aeroelastic analysis tools. Plant characteristics were determined from this model and verified by open loop experimental tests. A flutter suppression control law was designed and implemented on a digital control computer. Closed loop flutter testing was conducted. The experimental results represent the first time that adaptive materials have been used to actively suppress flutter. They demonstrate that small, carefully placed actuating plates can be used effectively to control aeroelastic response. Author

N93-20605# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.
YIDOYU AND ITS APPLICATION TO AIRCRAFT DESIGN
 XIANXUE XUN, QIHAO LONG, BINGCHEN PAN, and WENPU CHEN 7 Jan. 1993 19 p Transl. into ENGLISH from Hangkong Xuebao (China), v. 12, no. 6, Jun. 1991
 (AD-A259262; FASTC-ID(RS)-0316-92) Avail: CASI HC A03/MF A01

This paper is to introduce the essential techniques, special points, and a sketch on the procedure organization of the multi-constraint design optimization system for aircraft structures (YIDOYU) and also to reintroduce the present status of its systematic applications. From the results of some actual examples,

YIDOYU is shown to be a practical design optimization system, with the ability and efficiency to solve different structural optimization problems. GRA

N93-20742# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

LOAD EXPERIENCE VARIABILITY OF FIGHTER AIRCRAFT

J. B. DEJONGE 19 Jun. 1989 11 p Presented at Australian Aeronautical Conference, Melbourne, Australia, 9-11 Oct. 1989 (NLR-TP-89172-U; ETN-92-92854) Avail: CASI HC A03/MF A01

A statistical analysis was made of flight load data pertaining to about 10,000 F-104G operational flights. The distributions of load experience per flight could be fairly well approximated by Weibull distribution functions. Specific attention was paid to the differences in load experience per aircraft. Basic aspects of fatigue load monitoring are discussed. ESA

N93-21056# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Military Aircraft Div.

NUMERICAL METHODS FOR AEROTHERMODYNAMIC

DESIGN OF HYPERSONIC SPACE TRANSPORT VEHICLES

KLAUS MARKUS WANIE, ALFRED BRENNEIS, ALBRECHT EBERLE, and STEFAN HEISS Apr. 1992 16 p Presented at 70th AGARD Fluid Dynamics Panel Symposium on Theoretical and Experimental Methods in Hypersonic Flows, Turin, Italy, 4-8 May 1992

(MBB-FE-211-S-PUB-0481; ETN-93-93427) Copyright Avail: CASI HC A03/MF A01

A pair of numerical methods for predicting the flow past hypersonic vehicle configurations that include wings, fins, flaps, and a propulsion system, are described. The governing equations and fundamental details of the solution methods are reviewed. Results for both geometrically simple test cases and realistic hypersonic configurations are given. Since there is still a considerable lack of experience for hypersonic flow calculations, extensive testing and verification are essential. This verification is done by comparison of results with experimental data and other numerical methods. The results presented prove that the methods used are robust, flexible, and accurate enough to fulfill the needs of the design process. ESA

N93-21305# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

THE TESTING OF FIXED WING TANKER AND RECEIVER AIRCRAFT TO ESTABLISH THEIR AIR-TO-AIR REFUELLING CAPABILITIES, VOLUME 11 [LES ESSAIS PRATIQUES SUR LES AVIONS RAVITAILLEURS ET RAVITAILLES AFIN DE DETERMINER LEURS CAPACITES DE RAVITAILLEMENT EN VOL]

JOHN BRADLEY (Aircraft and Armament Evaluation Establishment, Boscombe Down, England.) and KAREN EMERSON (Aircraft and Armament Evaluation Establishment, Boscombe Down, England.) Dec. 1992 27 p *Its* Flight Test Techniques Series (AGARD-AG-300-VOL-11; ISBN-92-835-0698-7) Copyright Avail: CASI HC A03/MF A01

Since its founding in 1952, the Advisory Group for Aerospace Research and Development has published, through the Flight Mechanics Panel, a number of standard texts in the field of flight testing. The original Flight Test Manual was published in the years of 1954 to 1956. The Manual was divided into four volumes: (1) performance; (2) stability and control; (3) instrumentation catalog; and (4) instrumentation systems. This AGARDograph therefore describes the points that need to be considered when planning AAR trials to clear a new tanker or a new receiver aircraft for Service use. The paper assumes some familiarity with current AAR practices and equipment. It covers the two AAR systems in widespread use, namely the probe and drogue, and boom refuelling systems. Many of the points that need to be considered are common to both. Derived from text

N93-21310*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A GOVERNMENT/INDUSTRY SUMMARY OF THE DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM

RAYMOND G. KVATERNIK, comp. Jan. 1993 58 p Proceedings of AIAA 33rd Structures, Structural Dynamics and Materials Conference, Dallas, TX, 13-15 Apr. 1992 (Contract RTOP 505-63-36-01) (NASA-CP-10114; NAS 1.55:10114) Avail: CASI HC A04/MF A01

The NASA Langley Research Center in 1984 initiated a rotorcraft structural dynamics program, designated DAMVIBS (Design Analysis Methods for VibrationS), with the objective of establishing the technology base needed by the rotorcraft industry for developing an advanced finite-element-based dynamics design analysis capability for vibrations. An assessment of the program showed that the DAMVIBS Program has resulted in notable technical achievements and major changes in industrial design practice, all of which have significantly advanced the industry's capability to use and rely on finite-element-based dynamics analyses during the design process.

N93-21311*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM: A GOVERNMENT OVERVIEW

RAYMOND G. KVATERNIK *In its* A Government/Industry Summary of the Design Analysis Methods for Vibrations (DAMVIBS) Program p 1-10 Jan. 1993 Previously announced as A92-34390

Avail: CASI HC A02/MF A01

NASA-Langley, under the Design Analysis Methods for Vibrations (DAMVIBS) Program, set out in 1984 to establish the technology base needed by the rotorcraft industry for developing an advanced finite-element-based dynamics design analysis capability for vibrations. Considerable work has been done by the industry participants in the program since that time. Because the DAMVIBS Program is being phased out, a government/industry assessment of the program has been made to identify those accomplishments and contributions which may be ascribed to the program. The purpose of this paper is to provide an overview of the program and its accomplishments and contributions from the perspective of the government sponsoring organization. Author

N93-21312*# Bell Helicopter Co., Fort Worth, TX.

THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR VIBRATIONS (DAMVIBS) PROGRAM : BELL HELICOPTER TEXTRON ACCOMPLISHMENTS

JAMES D. CRONKHITE *In* NASA. Langley Research Center, A Government/Industry Summary of the Design Analysis Methods for Vibrations (DAMVIBS) Program p 11-22 Jan. 1993 Previously announced as A92-34391

Accurate vibration prediction for helicopter airframes is needed to 'fly from the drawing board' without costly development testing to solve vibration problems. The principal analytical tool for vibration prediction within the U.S. helicopter industry is the NASTRAN finite element analysis. Under the NASA DAMVIBS research program, Bell conducted NASTRAN modeling, ground vibration testing, and correlations of both metallic (AH-1G) and composite (ACAP) airframes. The objectives of the program were to assess NASTRAN airframe vibration correlations, to investigate contributors to poor agreement, and to improve modeling techniques. In the past, there has been low confidence in higher frequency vibration prediction for helicopters that have multibladed rotors (three or more blades) with predominant excitation frequencies typically above 15 Hz. Bell's findings under the DAMVIBS program, discussed in this paper, included the following: (1) accuracy of finite element models (FEM) for composite and metallic airframes generally were found to be comparable; (2) more detail is needed in the FEM to improve higher frequency prediction; (3) secondary structure not normally

included in the FEM can provide significant stiffening; (4) damping can significantly affect phase response at higher frequencies; and (5) future work is needed in the areas of determination of rotor-induced vibratory loads and optimization. Author

**N93-21313*# Boeing Helicopter Co., Philadelphia, PA.
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR
VIBRATIONS (DAMVIBS) PROGRAM: BOEING HELICOPTERS
AIRFRAME FINITE ELEMENT MODELING**

R. GABEL, P. LANG, and D. REED /In NASA. Langley Research Center, A Government/Industry Summary of the Design Analysis Methods for Vibrations (DAMVIBS) Program p 23-34 Jan. 1993 Previously announced as A92-34392 (Contract NAS1-16460; NAS1-17497) Avail: CASI HC A03/MF A01

Mathematical models based on the finite element method of structural analysis, as embodied in the NASTRAN computer code, are routinely used by the helicopter industry to calculate airframe static internal loads used for sizing structural members. Historically, less reliance has been placed on the vibration predictions based on these models. Beginning in the early 1980's NASA's Langley Research Center initiated an industry wide program with the objective of engendering the needed trust in vibration predictions using these models and establishing a body of modeling guides which would enable confident future prediction of airframe vibration as part of the regular design process. Emphasis in this paper is placed on the successful modeling of the Army/Boeing CH-47D which showed reasonable correlation with test data. A principal finding indicates that improved dynamic analysis requires greater attention to detail and perhaps a finer mesh, especially the mass distribution, than the usual stress model. Post program modeling efforts show improved correlation placing key modal frequencies in the b/rev range with 4 percent of the test frequencies. Author

**N93-21314*# McDonnell-Douglas Helicopter Co., Mesa, AZ.
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR
VIBRATIONS (DAMVIBS) PROGRAM: MCDONNELL-DOUGLAS
HELICOPTER COMPANY ACHIEVEMENTS**

MOSTAFA TOOSSI, RICHARD WEISENBURGER, and MOSTAFA HASHEMI-KIA /In NASA. Langley Research Center, A Government/Industry Summary of the Design Analysis Methods for Vibrations (DAMVIBS) Program p 35-45 Jan. 1993 Previously announced as A92-34393 Avail: CASI HC A03/MF A01

This paper presents a summary of some of the work performed by McDonnell Douglas Helicopter Company under NASA Langley-sponsored rotorcraft structural dynamics program known as DAMVIBS (Design Analysis Methods for VibrationS). A set of guidelines which is applicable to dynamic modeling, analysis, testing, and correlation of both helicopter airframes and a large variety of structural finite element models is presented. Utilization of these guidelines and the key features of their applications to vibration modeling of helicopter airframes are discussed. Correlation studies with the test data, together with the development and applications of a set of efficient finite element model checkout procedures, are demonstrated on a large helicopter airframe finite element model. Finally, the lessons learned and the benefits resulting from this program are summarized. Author

**N93-21315*# Sikorsky Aircraft, Stratford, CT.
THE NASA/INDUSTRY DESIGN ANALYSIS METHODS FOR
VIBRATIONS (DAMVIBS) PROGRAM: SIKORSKY AIRCRAFT:
ADVANCES TOWARD INTERACTING WITH THE AIRFRAME
DESIGN PROCESS**

WILLIAM J. TWOMEY /In NASA. Langley Research Center, A Government/Industry Summary of the Design Analysis Methods for Vibrations (DAMVIBS) Program p 47-56 Jan. 1993 Previously announced as A92-34394 Avail: CASI HC A02/MF A01

A short history is traced of the work done at Sikorsky Aircraft under the NASA/industry DAMVIBS program. This includes both work directly funded by the program as well as work which was internally funded but which received its initial impetus from

DAMVIBS. The development of a finite element model of the UH-60A airframe having a marked improvement in vibration-predicting ability is described. A new program, PAREDYM, developed at Sikorsky, which automatically adjusts an FEM so that its modal characteristics match test values, is described, as well as the part this program played in the improvement of the UH-60A model. Effects of the bungee suspension system on the shake test data used for model verification are described. The impetus given by the modeling improvement, as well as the recent availability of PAREDYM, has brought for the first time the introduction of low-vibration design into the design cycle at Sikorsky. Author

N93-21401# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany). Military Aircraft Div.

**THE INTEGRATED DESIGN AND MANUFACTURING OF
COMPOSITE STRUCTURES FOR AIRCRAFT USING AN
ADVANCED TAPE LAYERING TECHNOLOGY**

G. BERCHTOLD and J. KLENNER (Messerschmitt-Boelkow-Blohm G.m.b.H., Augsburg, Germany.) 22 Jul. 1992 14 p (MBB-LME-251-S-PUB-0491-A; ETN-93-93433) Copyright Avail: CASI HC A03/MF A01

Since composite technology still suffers from several weak points such as the lack of adequate mechanized tape application techniques for complex compound structures, unsatisfying design methods, and missing continuous computer aided design/computer aided manufacturing linkage that result in long lead times and high production costs, an 'integrated tape laying system' for automated manufacturing of complex parts is described. This system uses a new tape steering technology. The steering technology's potentials and restrictions are integrated completely in the design process to avoid time consuming iteration loops and to optimize the structure. To be able to understand the detailed process, a short overview of the complete aircraft process from design to manufacturing is given. From this, the optimal detailed process is derived, with an important influence from the specific manufacturing technology. Some remarks on economic potentials are outlined in a typical example. ESA

N93-21479# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Produktbereich Militaerflugzeuge.

**SELECTION CRITERIA FOR METALLIC HIGH TEMPERATURE
STRUCTURAL MATERIALS IN HYPERSONIC FLYING
EQUIPMENT [AUSWAHLKRITERIEN FUER METALLISCHE
HEISSTRUKTURWERKSTOFFE IN
HYPERSCHELLFLUGGERAETEN]**

R. LANG and D. WEISGERBER 17 Jul. 1992 8 p In GERMAN Presented at Deutscher Luft- und Raumfahrtkongress/DGLR-Jahrestagung 1992, Bremen, Germany, 29 Sep. - 2 Oct. 1992 Submitted for publication (MBB-LME-221-HYPAC-PUB-2-A; ETN-93-93432) Avail: CASI HC A02/MF A01

It is shown that high mechanical characteristic values and oxidation resistance in total temperature spectra, and manufacturing properties, such as workability and weldability have a primary influence on hypersonic material selection, besides the availability of materials and semiproducts. The selection of materials is to follow a high ranking concept, which takes into consideration the consequences of the combination of various materials. Titanium alloys and superalloys which meet with lightweight construction and manufacturing requirements for high temperature structures were selected among a number of possible metallic materials. ESA

**N93-21646*# Colorado Univ., Boulder.
HSCT MISSION ANALYSIS OF WAVERIDER DESIGNS
Quarterly Progress Report No. 2, 15 Aug. 1991 - 15 Nov. 1992**

15 Nov. 1992 13 p Original contains color illustrations (Contract NAG1-1295)

(NASA-CR-192193; NAS 1.26:192193; REPT-153-6442) Avail: CASI HC A03/MF A01; 3 functional color pages

In the second quarter the development of the two waverider design tools was continued, and the groundwork necessary for

the incorporation of waverider technology into the realm of the High Speed Civil Transports (HSCT's) was laid out. Advances in each of these areas is summarized. Work on the WIPAR code included the addition of an upper surface geometry generator and characteristic flow solver and the inclusion of viscous analysis in the performance computations. Details of these changes are given. In the course of the second project quarter, much of the analysis performed during the first quarter was incorporated into a working computer code. To date, utilities were developed for the definition of arbitrary 3-D shock surfaces, the computation of post-shock flow conditions, and the marching of the solution in a roughly cross-stream direction away from the shock surface. These utilities are briefly described. During the second quarter groundwork for the analysis of complete configurations was initiated. This involved the development of computational utilities for the integration of powerplants with the waverider forebodies, and the acquisition of a number of configuration analysis software packages. Work in these areas is discussed. Derived from text

N93-21762# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Abt. Hochgeschwindigkeitsstroemungen.

EXPERIMENTAL INVESTIGATIONS ON WING-BODY COMBINATIONS AND THEIR COMPONENTS AT HIGH ANGLES OF ATTACK IN THE SUBSONIC AND TRANSONIC SPEED RANGE [RUMPF, GESTUTZTER DELTAFLUEGEL, STROEMUNGSABLOESUNG, KRAFT- UND MOMENTENMESSUNG, INTERFERENZEN]

KLAUS HARTMANN and S. R. PATIL (National Aeronautical Lab., Bangalore, India.) Oct. 1991 86 p (ISSN 0939-2963)

(DLR-FB-91-43; ETN-93-91932) Avail: CASI HC A05/MF A01; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

Documentation and interpretation of experimental results obtained from force and moment measurements on a body of revolution, different cropped delta wings, and their wing body combinations are considered. The experiments were carried out in the transonic wind tunnel. They comprise the Mach number range from 0.5 to 1.2 at angles of attack up to 30 deg. In some cases, the Reynolds number was also varied. The results form a data base which is aimed at the validation and improvement of prediction methods and helps to lead to a better understanding of the complex three dimensional separated flow fields. ESA

N93-21810*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

TEST TECHNIQUES FOR EVALUATING FLIGHT DISPLAYS

LORAN A. HAWORTH and RICHARD L. NEWMAN Feb. 1993 18 p

(Contract RTOP 505-64-36)

(NASA-TM-103947; A-92139; NAS 1.15:103947;

ATCOM-TR-92-A-006; AD-A260295) Avail: CASI HC A03/MF A01

The rapid development of graphics technology allows for greater flexibility in aircraft displays, but display evaluation techniques have not kept pace. Historically, display evaluation has been based on subjective opinion and not on the actual aircraft/pilot performance. Existing electronic display specifications and evaluation techniques are reviewed. A display rating technique analogous to handling qualities ratings was developed and is recommended for future evaluations. The choice of evaluation pilots is also discussed and the use of a limited number of trained evaluators is recommended over the use of a large number of operational pilots. Author

N93-22003*# Arizona State Univ., Tempe. Coll. of Engineering and Applied Sciences.

DEVELOPMENT OF A NON-LINEAR SIMULATION FOR GENERIC HYPERSONIC VEHICLES - ASUHS1 Interim Task Report

JUAN SALAS, T. ALAN LOVELL, and DAVID K. SCHMIDT Feb. 1993 61 p

(Contract NAG1-1341)

(NASA-CR-192710; NAS 1.26:192710; ARC-93-1) Avail: CASI HC A04/MF A01

A nonlinear simulation is developed to model the longitudinal motion of a vehicle in hypersonic flight. The equations of motion pertinent to this study are presented. Analytic expressions for the aerodynamic forces acting on a hypersonic vehicle which were obtained from Newtonian Impact Theory are further developed. The control surface forces are further examined to incorporate vehicle elastic motion. The purpose is to establish feasible equations of motion which combine rigid body, elastic, and aeropropulsive dynamics for use in nonlinear simulations. The software package SIMULINK is used to implement the simulation. Also discussed are issues needing additional attention and potential problems associated with the implementation (with proposed solutions). Author (revised)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A93-24750*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

APPLICATION OF A FLUSH AIRDATA SENSING SYSTEM TO A WING LEADING EDGE (LE-FADS)

STEPHEN A. WHITMORE, TIMOTHY R. MOES, MARK W. CZERNIEJEWSKI, and DOUGLAS A. NICHOLS (NASA, Flight Research Center, Edwards, CA) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0634) Copyright

This paper investigates the feasibility of locating a flush air-data sensing (FADS) system on a wing leading edge where the operation of the avionics or fire control radar system will not be hindered. The leading-edge FADS system (LE-FADS) was installed on an unswept symmetrical airfoil, and a series of low-speed wind-tunnel tests were conducted to evaluate the performance of the system. As a result of the tests it is concluded that the aerodynamic models formulated for use on aircraft nosetips are directly applicable to wing leading edges and that the calibration process is similar. Furthermore, the agreement between the air-data calculations for angle of attack and total pressure from the LE-FADS and known wind-tunnel values suggest that wing-based flush air-data systems can be calibrated to a high degree of accuracy. Static wind-tunnel tests for angles of attack from -50 to 50 deg and dynamic pressures from 3.6 to 11.4 lb/sq ft were performed. Author

A93-24835#

CWAS - CLEAN WING ADVISORY SYSTEM: A NEW APPROACH TO ICE DETECTION

JORMA ELORANTA (Finnair, Vantaa, Finland) and DONATO CARPARELLI (Vibro-Meter, S.A., Fribourg, Switzerland) Jan. 1993 6 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993

(AIAA PAPER 93-0747) Copyright

CWAS system aimed at detecting wing upper surface contamination of commercial type aircraft is described. The system uses sensors of proven technology mounted on wing upper surface. A simulation was performed of a B737 wing section of tank area with data recording systems and real time weather parameter collecting systems attached. Preliminary test results show that the detection rate for ice and slush is good and for frost only adjustments are needed. O.G.

A93-25922

HIGH VOLTAGE QUICK-DISCONNECT HARNESS SYSTEM FOR HELMET-MOUNTED DISPLAYS

P. T. BAPU, S. P. FUCHS, J. M. AULDS (Dayton Univ., OH), and DAVE MCCORMICK (Reynolds Industries, Inc., Los Angeles, CA) *In* IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 1 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 1.477-1.481. refs
(Contract F33615-86-D-0540; F33615-89-C-0532)

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We have developed a pilot's harness-mounted, high-voltage quick-disconnect connector for a binocular, helmet-mounted display system. It connects and disconnects with power off, and disconnects 'hot' without pilot intervention, external sparks, or exposed hot embers in the explosive environment of the cockpit. Furthermore, we have successfully implemented a procedure in which high-voltage pins of up to 13.5 kV disconnect inside a hermetically sealed unit before the physical separation of the connector. The locations of the conductors and shields are designed to avoid crosstalk among adjacent circuits. The connector shell is equipped to house and cool two hybrid video amplifiers that provide up to 70 MHz video bandwidth to the helmet-mounted CRTs. The connector shell has been human-engineered to facilitate the arm, head, and torso movements of the pilot. Shielded cables and wires are potted as a multilayered ribbon for maximum flexibility between the connector and helmet. Stiff cabling is routed between the connected and the aircraft panel to avoid dangling cables during seat ejection. The system has been successfully tested for specifications, performance, and safety factors. Author

A93-26882

SURVEY OF HELMET TRACKING TECHNOLOGIES

FRANK J. FERRIN (Honeywell, Inc., Military Avionics Div., Minneapolis, MN) *In* Large-screen-projection, avionic, and helmet-mounted displays; Proceedings of the Meeting, San Jose, CA, Feb. 26-28, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 86-94.

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Helmet-mounted sights, also known as 'head trackers', have been mechanized on the basis of various technologies, each of which possesses distinctive advantages and weaknesses. The most attractive of these head tracking-implementing technologies are magnetic, electrooptic, and ultrasonic; attention is given to a tabulation of the results of a comparative evaluation among such systems. All of the technologies are noted to employ transducers that are potentially susceptible to interference by ambient radiation of the same type employed (IR, ultrasonic, magnetic). O.C.

A93-26883

HELMET MOUNTED SIGHT AND DISPLAY TESTING

H.-D. V. BOEHM, H. SCHREYER, and R. S. SCHRANNER (MBB GmbH, Munich, Germany) *In* Large-screen-projection, avionic, and helmet-mounted displays; Proceedings of the Meeting, San Jose, CA, Feb. 26-28, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 95-123. Previously announced in STAR as N92-12421 refs

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The results of conducted tests of Helmet Mounted Sights (HMS) and Helmet Mounted Displays (HMD) are presented. To compare the accuracy of the different HMS Systems (on magnetic, acoustic or optical basis) it is intended to find and unify a test procedure for verification. The test conditions vary, dependent on the principle of the HMS system. Magnetic systems should be tested with the influence of magnetic disturbances, ultrasonic systems under occurrence of noise and changing characteristics of the dispersion medium air, optical systems under high luminance to check saturation effects of the sensors. Modern Integrated Helmets (IH) consist of Cathode Ray Tubes (CRTs) for displaying binocular images of television or infrared cameras and superimposed symbology and a second channel with Image Intensifier Tubes (IIT). Important points for checking CRTs are the resolution, distortion, homogeneity and brightness in day and night time. The most important test for the IIT channel is the resolution measured as a function of luminance of the test pattern. Tests of the basic helmet regarding head fit, earphone, center of gravity,

weight etc. are also necessary because these properties have an influence on the performance of the complete man machine system. Author

A93-26884* National Aeronautics and Space Administration, Washington, DC.

VISUAL FIELD INFORMATION IN NAP-OF-THE-EARTH FLIGHT BY TELEOPERATED HELMET-MOUNTED DISPLAYS

ARTHUR J. GRUNWALD, S. KOHN, and S. J. MERHAV (Technion - Israel Inst. of Technology, Haifa) *In* Large-screen-projection, avionic, and helmet-mounted displays; Proceedings of the Meeting, San Jose, CA, Feb. 26-28, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 132-153. refs

(Contract NAGW-1128)

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The human ability to derive Control-Oriented Visual Field Information from teleoperated Helmet-Mounted displays in Nap-of-the-Earth flight, is investigated. The visual field with these types of displays originates from a Forward Looking Infrared Radiation Camera, gimbal-mounted at the front of the aircraft and slaved to the pilot's line-of-sight, to obtain wide-angle visual coverage. Although these displays are proved to be effective in Apache and Cobra helicopter night operations, they demand very high pilot proficiency and work load. Experimental work presented in the paper has shown that part of the difficulties encountered in vehicular control by means of these displays can be attributed to the narrow viewing aperture and head/camera slaving system phase lags. Both these shortcomings will impair visuo-vestibular coordination, when voluntary head rotation is present. This might result in errors in estimating the Control-Oriented Visual Field Information vital in vehicular control, such as the vehicle yaw rate or the anticipated flight path, or might even lead to visuo-vestibular conflicts (motion sickness). Since, under these conditions, the pilot will tend to minimize head rotation, the full wide-angle coverage of the Helmet-Mounted Display, provided by the line-of-sight slaving system, is not always fully utilized. Author

A93-26886

DESIGN OF AN OPTIMAL SINGLE REFLECTIVE

HOLOGRAPHIC HELMET DISPLAY ELEMENT

PATRICE TWARDOWSKI and PATRICK MEYRUEIS (Strasbourg, Ecole Nationale Supérieure de Physique, France) *In* Large-screen-projection, avionic, and helmet-mounted displays; Proceedings of the Meeting, San Jose, CA, Feb. 26-28, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 164-174. refs

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An holographic optical element (HOE) can serve both as an imaging lens and a combiner for the helmet mounted display. The resulting image is created by points whose geometrical conditions at readout will differ from those at recording and then severe aberrations occur. Using the method of Hasman and Friesem, we design an optimal single reflective holographic helmet display element. This theoretical method is based on an analytic ray-tracing procedure that uses the minimization of the mean-squared difference of the propagation vector components between the actual output wave fronts and the desired output wave fronts. Considering the two-dimensional and monochromatic case, we obtain integral equations for the optimal grating vector components that we solve. As an illustration, we calculate the grating vector and we determine the performance of a holographic helmet display with a 16 x 16 deg field of view. We determine the spot sizes and distortions at the image plane and the mean-squared difference of the propagation vectors. At the end we compare the results with the performance of an HOE recorded with a spherical wave and a plane wave. Author

A93-27239

A SURVEY OF DISPLAY TECHNOLOGIES FOR MILITARY AIRCRAFT COCKPIT APPLICATIONS

EARL RATLIFF (Astronautics Corp. of America, Milwaukee, WI) *In* High-resolution displays and projection systems; Proceedings

of the Meeting, San Jose, CA, Feb. 11, 12, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 66-89.
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Development status evaluations are presented for such cockpit display technologies as monochrome, raster-scan, shadow-masked and color CRTs, the single-gun CRT 'color-beam index' system, active-matrix liquid crystal displays (LCDs), field-emission displays, and plasma displays. Also noted are the development prospects for such projection-display techniques as holographic optical elements, LCD projection displays, and liquid-crystal shutters. All evaluations are made in view of the diverse requirements of high performance military and transport-aircraft cockpit environments.

O.C.

A93-27242* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PERFORMANCE CONSIDERATIONS FOR HIGH-DEFINITION HEAD-MOUNTED DISPLAYS

OLIVER J. EDWARDS (S-TRON, Mountain View, CA), JAMES LARIMER (NASA, Ames Research Center, Moffett Field, CA), and JENNIFER GILLE (National Research Council, Moffett Field, CA) /n High-resolution displays and projection systems; Proceedings of the Meeting, San Jose, CA, Feb. 11, 12, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 141-149.

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Design image-optimization for helmet-mounted displays (HMDs) for military systems is presently discussed within the framework of a systems-engineering approach that encompasses (1) a description of natural targets in the field; (2) the characteristics of human visual perception; and (3) device specifications that directly relate to these ecological and human-factors parameters. Attention is given to target size and contrast and the relationship of the modulation transfer function to image resolution.

O.C.

A93-27499

INCREASED SAFETY THROUGH KNOWLEDGE-BASED PILOT ASSISTANCE

HEINZ-LEO DUDEK and PETER LUX Dornier Post (ISSN 0012-5563) no. 4 1992 p. 35-37.

A Cockpit Assistant System (Cassy) being developed by Dornier Luftfahrt GmbH in cooperation with the University of the German Forces is briefly discussed. The Cassy system which is capable of dealing with situation assessment, flight planning, and services is based on sophisticated interfaces for the flight crew, the aircraft's avionics system, and the air traffic control, which use voice as means of communication.

O.G.

A93-28176

ADVANCED AIRBORNE 3D COMPUTER IMAGE GENERATION SYSTEMS TECHNOLOGIES FOR THE YEAR 2000

ALAN L. BRIDGES (SCI Systems, Inc., Huntsville, AL) /n Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 238-249. refs

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The paper discusses the requirements of advanced airborne 3D computer image generation systems (CIGSs) of the future. These include advanced avionics system architecture requirements and BIT/fault tolerance; real-time operating systems and graphic interface languages in Ada; and geometric/pixel processing functions, rendering system, and frame buffers/display controllers for pictorial displays. High-performance graphics engines, powerful floating point processors, and parallel architectures will be needed to increase the rendering speed, functionality, and reliability of future CIGSs, while reducing power, space requirements, and cost. Block diagrams are presented illustrating a future cockpit image generation system, a generic rendering system, and a parallel CIGS architecture.

I.S.

A93-28179

AN AC THIN FILM ELECTROLUMINESCENT (TFEL) DISPLAY UNIT FOR COCKPIT CONTROL DISPLAY UNIT APPLICATION

ALAN L. BRIDGES (SCI Systems, Inc., Huntsville, AL) /n Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 270-284. refs

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The salient features of a newly developed prototype thin-film electroluminescent (TFEL) display unit (DU) designed for cockpit control display unit applications are discussed. These features include high brightness and contrast, sunlight readability, night vision goggle compatibility, light weight, low power, automatic brightness control based on ambient light conditions, modular design, ease of assembly and test, and high reliability. The electronics are straightforward using LSI components. The TFEL DUs can be easily converted for other display needs.

I.S.

N93-19783#

Sextant Avionique, Saint Medard en Jalles (France).

LIQUID CRYSTAL DISPLAYS REPLACING THE CRT AND CLE OF FUTURE COCKPITS (LES ECRANS A CRISTAUX LIQUIDES REMPLACANT DU CRT ET CLE DES FUTURS COCKPITS)

FREDERIC DELAUZUN /n AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface 9 p Oct. 1992 In FRENCH

Copyright Avail: CASI HC A02/MF A03

Due to well-known advantages such as low weight, reduced volume, low consumption, visibility (under high brightness) reliability, to mention the most important, the flat panels have already started to replace the CRT in the world of military aircraft. Among flat panels, the liquid crystal active matrix display is the most advanced. Full colors and grey shades displays are mass produced for commercial applications and new military cockpits, both for airplanes and helicopters based on that technology (Rafale is used as an example to illustrate the advantages of LCD compared to CRT). Furthermore, liquid crystal panel is a technical key which will help future cockpit concepts to wake-up to life. The head level display and the large interactive display are among them. Projection techniques and liquid crystal cells are merged to take benefits of liquid crystal, removing the drawbacks (that notion is illustrated by a brief description of a head level display demonstrator).

Author

N93-20163*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

APPLICATION OF A FLUSH AIRDATA SENSING SYSTEM TO A WING LEADING EDGE (LE-FADS)

STEPHEN A. WHITMORE, TIMOTHY R. MOES, MARK W. CZERNIEJEWSKI, and DOUGLAS A. NICHOLS Feb. 1993 17 p Presented at the AIAA 31st Aerospace Sciences Meeting, Reno, NV, 11-14 Jan. 1993

(Contract RTOP 505-68-40)

(NASA-TM-104267; H-1886; NAS 1.15:104267; AIAA PAPER 93-0634) Avail: CASI HC A03/MF A01

The feasibility of locating a flush airdata sensing (FADS) system on a wing leading edge where the operation of the avionics or fire control radar system will not be hindered is investigated. The leading-edge FADS system (LE-FADS) was installed on an unswept symmetrical airfoil and a series of low-speed wind-tunnel tests were conducted to evaluate the performance of the system. As a result of the tests it is concluded that the aerodynamic models formulated for use on aircraft nosetips are directly applicable to wing leading edges and that the calibration process is similar. Furthermore, the agreement between the airdata calculations for angle of attack and total pressure from the LE-FADS and known wind-tunnel values suggest that wing-based flush airdata systems can be calibrated to a high degree of accuracy. Static wind-tunnel tests for angles of attack from -50 deg to 50 deg and dynamic pressures from 3.6 to 11.4 lb/sq ft were performed.

Author

N93-21259# Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.

SOFTWARE DESIGN DOCUMENT FOR THE GENERIC AVIONICS DATA BUS TOOL KIT

4 Oct. 1992 128 p
(AD-A259329) Avail: CASI HC A07/MF A02

This Software Design Document describes the structure of the Generic Avionics Data Bus Tool Kit (GADBTk), which is part of the Ada Technology Insertion Program's (ATIP) Ada binding project. The Computer Software Configuration Item (CSCI) described in this design document is a collection of related routines that will be combined to form a bus monitor application. The primary goal of the project is to produce reusable data bus software components. GRA

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A93-24026

ON CLOSED-LOOP IDENTIFICATION OF A CERTAIN AEROENGINE UNDER FLIGHT CONDITIONS

SIQI FAN (Northwestern Polytechnical Univ., Xian, China) and SHUREN LI (Flight Test Research Inst., China) Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 11, no. 1 Jan. 1993 p. 1-7. In Chinese. refs

The conditions a certain Chinese-made aeroengine (aeroengine C) must satisfy to ensure its identifiability are analyzed. The results of a comprehensive study of aeroengine C are reported that consider four aspects of identification: system identifiability, model category, test conditions, and methods of identification. C.D.

A93-24782*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

TAKEOFF/APPROACH NOISE FOR A MODEL COUNTERROTATION PROPELLER WITH A FORWARD-SWEPT UPSTREAM ROTOR

RICHARD P. WOODWARD (NASA, Lewis Research Center, Cleveland, OH), DAVID G. HALL (Sverdrup Technology, Inc., Brook Park, OH), GARY G. PODBOY, and ROBERT J. JERACKI (NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 22 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Previously announced in STAR as N93-16715 refs

(AIAA PAPER 93-0596) Copyright

A scale model of a counterrotating propeller with forward-swept blades in the forward rotor and aft-swept blades in the aft rotor (designated F39/A31) has been tested in the NASA Lewis 9- by 15-Foot Anechoic Wind Tunnel. This paper presents aeroacoustic results at a takeoff/approach condition of Mach 0.20. Laser Doppler Velocimeter results taken in a plane between the two rotors are also included to quantify the interaction flow field. The intention of the forward-swept design is to reduce the magnitude of the forward rotor tip vortex and/or wakes which impinge on the aft rotor, thus lowering the interaction tone levels. Author

A93-24829#

ANALYTICAL INVESTIGATION OF A REGENERATIVELY COOLED SCRAMJET ENGINE

TAKESHI KANDA, GORO MASUYA, and AKIO MORO (National Aerospace Lab., Kakuda Research Center, Japan) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0739) Copyright

In order to evaluate the influences of regenerative cooling and of selection of engine wall material on engine performances, a

regeneratively cooled scramjet engine was simulated with multistep quasi 1D calculations. This simulation clarified that regenerative cooling resulted additional thrust not only due to conversion from heat to kinetic energy, but also due to reduction of net entropy increment. This effect on specific impulse became larger with increment in the amount of heat exchanged and also with increment of flight Mach number. Material with a high level of thermal conductivity was found to be suitable for engine walls to be cooled regeneratively, even though its allowable maximum temperature was not very high. Using the same simulation procedure, it was also clarified that total pressure recovery of the inlet did not greatly affect specific impulse when it changed within an order of the magnitude. It was because impulse function did not greatly change by total pressure loss in a hypersonic flow. Author

A93-25997 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARISON OF ALL-ELECTRIC SECONDARY POWER SYSTEMS FOR CIVIL TRANSPORT

DAVID D. RENZ (NASA, Lewis Research Center, Cleveland, OH) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 2 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 2.451-2.454. Previously announced in STAR as N93-10456 refs

(Contract RTOP 538-01-10)

Copyright

Three separate studies have shown operational, weight, and cost advantages for commercial subsonic transport aircraft using an all-electric secondary power system. The first study in 1982 showed that all-electric secondary power systems produced the second largest benefit compared to four other technology upgrades. The second study in 1985 showed a 10 percent weight and fuel savings using an all-electric high frequency (20 kHz) secondary power system. The last study in 1991 showed a 2 percent weight savings using today's technology (400 Hz) in an all-electric secondary power system. This paper will compare the 20 kHz and 400 Hz studies, analyze the 2 to 10 percent difference in weight savings and comment on the common benefits of the all-electric secondary power system. Author

A93-25998

EVOLUTION OF THE BOEING 777 ELECTRICAL POWER SYSTEM

CARL B. TENNING (Boeing Commercial Airplane Group, Seattle, WA) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 2 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 2.455-2.460.

Copyright

Major steps in the evolution of the Boeing 777 electrical power system are reviewed. The provision of the captain's instruments on standby power, the simplification of the transfer bus switching, the powering of the main 28 VDC system from transfer buses, the division of the 28 VDC system into four channels, simultaneous ground operation on APU and external power, the separation of the captain's flight instrument bus from the battery bus, and the addition of a second external power receptacle are discussed. Block diagrams are used to illustrate these changes. C.D.

A93-26114

HEAT PIPE TURBINE VANE COOLING

JOSEPH M. GOTTSCHLICH and MATTHEW MEININGER (USAF, Wright-Patterson AFB, OH) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 6 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 6.133-6.138. Research sponsored by USAF

Copyright

The basic feasibility and anticipated benefits to using heat pipe technology to cool the turbine vanes of gas turbine engines are presented. This concept involves fitting out the vane interior as a heat pipe, extending the vane into an adjacent heat sink and

then transferring the vane incident heat through the vane to the heat sink. An advanced military fighter engine is used as a baseline and the bypass air is the chosen heat sink. The results of this study show a 7.2-percent increase in engine thrust, a 0.2-percent decrease in specific fuel consumption with overall engine weight increased by less than 1 percent by using this technology.

Author

A93-27291

MODELLING OF THE FLOW IN THE BLADE-RING DESIGN PROCESS OF TURBOMACHINERY [MODELOWANIE PRZEPŁYWU W PROCESIE PROJEKTOWANIA WIENCOW LOPATKOWYCH MASZYN WIRNIKOWYCH]

TADEUSZ CHMIELNIAK, HENRYK LUKOWICZ, and WŁODZIMIERZ WROBLEWSKI (Politechnika Śląska, Gliwice, Poland) Politechnika Śląska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817) no. 103 1991 p. 51-54. In Polish. refs

This paper presents a method of turbomachinery blade-ring design. Only flow criteria are considered, without strength and technology criteria. Attention is focused on the determination of profile losses. Some calculation results are presented. Author

A93-27296

INFLUENCE OF MODELLING LOADING ON STRESS DISTRIBUTION IN TURBOMACHINERY BLADE FASTENING IN CASE OF FEM [WPŁYW MODELOWANIA OBCIĄŻENIA NA ROZKŁAD NAPREŻEN W ZAMOCOWANIU LOPATKI TURBINOWEJ W PRZYPADKU METODY ELEMENTOW SKONCZONYCH]

WIESŁAW OSTACHOWICZ (Polska Akademia Nauk, Instytut Maszyn Przepływowych, Gdansk, Poland) and GRZEGORZ ZBOŃSKI (Politechnika Gdanska, Gdansk, Poland) Politechnika Śląska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817) no. 103 1991 p. 189-192. In Polish. refs

An accurate method of modelling the loading of blade fastening is proposed. As an approximation, the method based on surface loadings imitating the cutoff part of the blade is proposed.

Author

A93-27478

CONTROL OF CONTAMINANTS IN GAS TURBINES WITH VARIABLE-FLOW COMBUSTION CHAMBERS AND HYDROGEN ADDITION [CONTROL DE CONTAMINANTES EN TURBINAS DE GAS CON CAMARAS DE RELACION DE FLUJO VARIABLE Y ADICION DE HIDROGENO]

J. J. SALVA MONFORT and G. LOPEZ JUSTE (Madrid, Univ. Politecnica, Spain) Ingenieria Aeronautica y Astronautica (ISSN 0020-1006) no. 330 1993 p. 32-41. In Spanish. refs Copyright

Variable-geometry gas turbine combustion chambers are a promising new concept for pollutant emission control. It is presently noted that the control of primary/total airflow values in a fixed-geometry combustor allows the achievement of a useful portion of the benefits projected for variable-geometry combustors, and that the injection of small quantities of hydrogen counteracts efficiency reductions and pollutant increases associated with off-design primary combustor zone conditions. O.C.

A93-27625

DETERMINATION OF GAS FLOW RATE IN A DUCT FROM MEASURED STATIC PRESSURES [OPREDELENIE RASKHODA GAZA V KANALE PO IZMERENNYM STATICHESKIM DAVLENIAM]

I. G. TSYBALOV and V. N. STEPANENKO (Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 95-98. In Russian. refs Copyright

A method is presented for determining gas flow rate in a duct from static pressures measured at two cross sections of different areas. A computational formula is obtained. The method is tested experimentally, and it is found that the gas flow rates determined by the method are highly accurate. V.L.

A93-27627

CONSIDERATION OF THE COMPLETENESS OF COMBUSTION AND DISSOCIATION AND RECOMBINATION PROCESSES IN MATHEMATICAL MODELS OF JET ENGINES FOR HIGH SUPERSONIC FLIGHT VELOCITIES [UCHET POLONOTY SGORANIYA, PROTSESSOV DISSOTSIIATSII I REKOMBINATSII V MATEMATICHESKIKH MODELIAKH VRD BOL'SHIKH SVERKHZVUKOVYKH SKOROSTEI POLETA]

V. I. BAKULEV and V. V. KOZLIAKOV (Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 102-105. In Russian. refs

Copyright

Mathematical models are developed for calculating the thermodynamic parameters of gas flow in the combustion chambers of jet engines for oxidizer excess coefficients equal to or greater than 1 and less than 1. The models allow for the dissociation of combustion products and the completeness of combustion. Models of a supersonic jet nozzle are also developed with allowance for recombination processes in gas flow. The thermodynamic parameters and composition of the working medium are calculated by using a modified version of the HNOC program. V.L.

A93-27739

POLYETHYLENE PYROLYSIS MODEL FOR COMBUSTION CALCULATIONS IN SOLID FUEL RAMJETS

J. P. DE WILDE (Delft Univ. of Technology, Netherlands) and P. J. M. ELANDS (TNO, Rijswijk, Netherlands) In Combustion and reaction kinetics; Proceedings of the 22nd International Annual Conference of ICT, Karlsruhe, Germany, July 2-5, 1991 Pfingsttal, Germany Fraunhofer-Institut fuer Chemische Technologie 1991 p. 39-1 to 39-14. Research supported by Stichting voor de Technische Wetenschappen refs

A model describing the pyrolysis of polyethylene has been developed which gives a relation between the regression rate and the pyrolysis temperature of the solid fuel. It also gives the composition of the pyrolysis products and the effective heat of gasification of the solid fuel at the pyrolysis temperature. The model has been implemented in a solid fuel ramjet CFD prediction computer code. The model yields values for the pyrolysis temperature that lie around 1000 to 1100 K, while literature values range from 700 to 900 K. L.M.

A93-27801# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A NUMERICAL STUDY OF MIXING IN SUPERSONIC COMBUSTORS WITH HYPERMIXING INJECTORS

J. LEE (Sverdrup Technology, Inc., Lewis Research Center Group, Brook Park, OH) Jan. 1993 26 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Previously announced in STAR as N93-17884 refs (Contract NAS3-25266; RTOP 505-62-40) (AIAA PAPER 93-0215) Copyright

A numerical study was conducted to evaluate the performance of wall mounted fuel-injectors designed for potential Supersonic Combustion Ramjet (SCRAM-jet) engine applications. The focus of this investigation was to numerically simulate existing combustor designs for the purpose of validating the numerical technique and the physical models developed. Three different injector designs of varying complexity were studied to fully understand the computational implications involved in accurate predictions. A dual transverse injection system and two streamwise injector designs were studied. The streamwise injectors were designed with swept ramps to enhance fuel-air mixing and combustion characteristics at supersonic speeds without the large flow blockage and drag contribution of the transverse injection system. For this study, the Mass-Average Navier-Stokes equations and the chemical species continuity equations were solved. The computations were performed using a finite-volume implicit numerical technique and multiple block structured grid system. The interfaces of the multiple block structured grid systems were numerically resolved using the flux-conservative technique. Detailed comparisons between the computations and existing experimental data are presented. These comparisons show that numerical predictions are in agreement

with the experimental data. These comparisons also show that a number of turbulence model improvements are needed for accurate combustor flowfield predictions. Author

A93-28479**NOISE REDUCTION PROGRAMS FOR IN-SERVICE JET TRANSPORTS**

ALAN H. MARSH (DyTec Engineering, Inc., Huntington Beach, CA) /In Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 183-186.

Copyright

Recent reengine and retrofit options in view of regulations to require the complete phaseout by the early 21st century of operations by jet-powered airplanes that do not comply with noise-level standards of the U.S. Federal Aviation Regulations are examined. Effective perceived noise levels at the sideline, takeoff, and approach certification-measurement points, relative to Stage 3 noise level standards, are shown for selected versions of several reengineed or retrofitted airplanes. C.A.B.

A93-29655

COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION OF A SOLAR ENERGY SYSTEM FOR AN ATMOSPHERIC FLIGHT VEHICLE [RASCHETNO-TEORETICHESKOE I EKSPERIMENTAL'NOE ISSLEDOVANIE SOLNECHNOI ENERGOUSTANOVKI DLIA ATMOSFERNOGO LETATEL'NOGO APPARATA]

IU. B. VASIL'EV and IU. B. VOLGIN /In Problems in the development of flight-vehicle energy systems and their use in the national economy Moscow Izdatel'stvo MAI 1991 p. 25-31. In Russian. refs

Copyright

A method is proposed for calculating the output of the solar batteries of an atmospheric flight vehicle with allowance for the angular misalignment of solar cell elements with respect to the solar radiation. The angular misalignment of the solar cell elements is taken into account by using quantitative characteristics of the sensitivity of the electric power to the misalignment angle derived from a series of experiments on solar cells with different types of coatings (quartz glass and polyester film) and uncoated cells. A correction is also made for the presence of the diffuse background component. The method proposed here has been implemented in computer software. V.L.

N93-20583*# General Motors Corp., Indianapolis, IN. Gas Turbine Div.

INVESTIGATION OF ADVANCED COUNTERROTATION BLADE CONFIGURATION CONCEPTS FOR HIGH SPEED TURBOPROP SYSTEMS. TASK 5: UNSTEADY COUNTERROTATION DUCTED PROPFAN ANALYSIS. COMPUTER PROGRAM USER'S MANUAL Final Report

EDWARD J. HALL, ROBERT A. DELANEY, JOHN J. ADAMCZYK, CHRISTOPHER J. MILLER, ANDREA ARNONE, and CHARLES SWANSON Jan. 1993 211 p (Contract NAS3-25270; RTOP 535-03-10) (NASA-CR-187125; NAS 1.26:187125) Avail: CASI HC A10/MF A03

The primary objective of this study was the development of a time-marching three-dimensional Euler/Navier-Stokes aerodynamic analysis to predict steady and unsteady compressible transonic flows about ducted and unducted propfan propulsion systems employing multiple blade rows. The computer codes resulting from this study are referred to as ADPAC-AOACR (Advanced Ducted Propfan Analysis Codes-Angle of Attack Coupled Row). This report is intended to serve as a computer program user's manual for the ADPAC-AOACR codes developed under Task 5 of NASA Contract NAS3-25270, Unsteady Counterrotating Ducted Propfan Analysis. The ADPAC-AOACR program is based on a flexible multiple blocked grid discretization scheme permitting coupled 2-D/3-D mesh block solutions with application to a wide variety of geometries. For convenience, several standard mesh block

structures are described for turbomachinery applications. Aerodynamic calculations are based on a four-stage Runge-Kutta time-marching finite volume solution technique with added numerical dissipation. Steady flow predictions are accelerated by a multigrid procedure. Numerical calculations are compared with experimental data for several test cases to demonstrate the utility of this approach for predicting the aerodynamics of modern turbomachinery configurations employing multiple blade rows.

Author

N93-20735# Rolls-Royce Ltd., Derby (England). Aerospace Group.

SATISFYING THE CUSTOMER'S REQUIREMENTS

M. R. WILLIAMS 7 Apr. 1992 18 p Presented at Moscow Aero and Industry Engine 1992, Moscow, Russia, 6-12 Apr. 1992 (PNR-90988; ETN-92-92761) Copyright Avail: NTIS HC A03/MF A01

Requirements of customers for civil aeroengines, which have become the design and business philosophies of Rolls-Royce, and which have been applied throughout their heritage resulting in quality engineering, are discussed. These requirements are considered with respect to engineering quality of aeroengines and civil gas turbine engines. The following are discussed: mechanical integrity and reliability, thermal modeling and validation, fan/disc assembly design validation, derivative engine benefits, fan/disc assembly certification requirements, economic operation and environmental responsibility (emissions, noise). The Trent family and Trent 800 is focused upon. The definition and satisfaction of future requirements is discussed. ESA

N93-20773*# General Motors Corp., Indianapolis, IN. Allison Gas Turbine Div.

INVESTIGATION OF ADVANCED COUNTERROTATION BLADE CONFIGURATION CONCEPTS FOR HIGH SPEED TURBOPROP SYSTEMS. TASK 5: UNSTEADY COUNTERROTATION DUCTED PROPFAN ANALYSIS Final Report

EDWARD J. HALL and ROBERT A. DELANEY Jan. 1993 133 p Original contains color illustrations (Contract NAS3-25270; RTOP 535-03-10) (NASA-CR-187126; NAS 1.26:187126) Avail: CASI HC A07/MF A02; 15 functional cor pages

The primary objective of this study was the development of a time-marching three-dimensional Euler/Navier-Stokes aerodynamic analysis to predict steady and unsteady compressible transonic flows about ducted and unducted propfan propulsion systems employing multiple blade rows. The computer codes resulting from this study are referred to as ADPAC-AOACR (Advanced Ducted Propfan Analysis Codes-Angle of Attack Coupled Row). This document is the final report describing the theoretical basis and analytical results from the ADPAC-AOACR codes developed under task 5 of NASA Contract NAS3-25270, Unsteady Counterrotating Ducted Propfan Analysis. The ADPAC-AOACR Program is based on a flexible multiple blocked grid discretization scheme permitting coupled 2-D/3-D mesh block solutions with application to a wide variety of geometries. For convenience, several standard mesh block structures are described for turbomachinery applications. Aerodynamic calculations are based on a four-stage Runge-Kutta time-marching finite volume solution technique with added numerical dissipation. Steady flow predictions are accelerated by a multigrid procedure. Numerical calculations are compared with experimental data for several test cases to demonstrate the utility of this approach for predicting the aerodynamics of modern turbomachinery configurations employing multiple blade rows.

Author

N93-20913# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).

OPTIMIZATION AND SENSITIVITY COMPUTATIONS FOR THE CONCEPTION OF INTERNAL VENTILATION SYSTEM IN THE AIRCRAFT ENGINE

P. GIBERT (Groupe Informatique Scientifique et Technique, Sevres, France), P. GUYON (Groupe Informatique Scientifique et Technique, Sevres, France), J. BASTART, and Y. BAUDRY

1991 8 p Presented at GRECO and ENS, Cachan, France, 2-5 Apr. 1991

(ETN-93-93375) Avail: CASI HC A02/MF A01

A description of the physical system, and the state variables is given. The mechanical system is composed of a set of cavities joined by restrictions. The state unknowns of the problem, which characterize the working point when the system is supplied with air, are the temperatures and pressures of cavities and the mass flows of restrictions. Each restriction is characterized by a constitutive law defined by some geometrical and technological parameters. There are two classes of design variables: firstly, these restriction parameters for a subset of restriction; secondly, some given temperatures or pressures at the boundary of the circuit. The aim of optimization is to minimize the inlet mass flow subject to the constraint that the design leads to an adequate ventilation of the circuit. The objective function is generally the inlet mass flow. The constraints functions acting on pressures, temperatures, mass flows or any thermodynamic variable allow building of the admissible set of design variables which assumes an adequate ventilation. The numerical procedure for minimizing the objective function in the admissible set of design variables is analyzed. The state equation of the model is recalled, the sensitivity derivative computations are investigated by adjoint states, and then the optimization and numerical examples are introduced. ESA

N93-21173# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Abt. Flugmechanik der Drehfluegelflugzeuge.

THE INFLUENCE OF THE ROTOR TEST FACILITIES ROTEST AND ROTOS ON THE ROTOR INFLOW [UEBER DEN EINFLUSS DER ROTORVERSUCHSSTAENDE ROTEST UND ROTOS AUF DIE ROTORDURCHSTROMUNG IM DNW]

BEREND VANDERWALL and CHRISTIAN GOEPEL Jun. 1991 48 p In GERMAN (ISSN 0939-298X)

(DLR-MITT-91-16; ETN-93-91917) Avail: CASI HC A03/MF A01; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

Rotor simulation calculations made in connection with rotor tests in the DNW (German/Dutch windtunnel), using the test facilities ROTEST (Rotor Test Stand) and ROTOS (Rotor On String), are presented. The models describing the induced velocities at the rotor blades influenced rotor performance and rotor dynamics, by affecting the aerodynamic loads. The calculations were made using an incompressible panel method and the results were dependent on the rotor shaft tilt and on tunnel speed. It appeared necessary to have the induced flow of the test stands included in rotor simulation at tunnel speed higher than about 30 m/s, whereas the self induced velocities were more dominant at lower speed. ESA

N93-21210*# Purdue Univ., Indianapolis, IN. School of Mechanical Engineering.

APPLICATIONS OF ACTIVE ADAPTIVE NOISE CONTROL TO JET ENGINES Final Report, 1 Mar. 1992 - 28 Feb. 1993

RAHMAT SHOURESHI and LARRY BRACKNEY 8 Mar. 1993 17 p

(Contract NAG3-1272)

(NASA-CR-192277; NAS 1.26:192277) Avail: CASI HC A03/MF A01

During phase 2 research on the application of active noise control to jet engines, the development of multiple-input/multiple-output (MIMO) active adaptive noise control algorithms and acoustic/controls models for turbofan engines were considered. Specific goals for this research phase included: (1) implementation of a MIMO adaptive minimum variance active noise controller; and (2) turbofan engine model development. A minimum variance control law for adaptive active noise control has been developed, simulated, and implemented for single-input/single-output (SISO) systems. Since acoustic systems tend to be distributed, multiple sensors, and actuators are more appropriate. As such, the SISO minimum variance controller was extended to the MIMO case. Simulation and experimental results

are presented. A state-space model of a simplified gas turbine engine is developed using the bond graph technique. The model retains important system behavior, yet is of low enough order to be useful for controller design. Expansion of the model to include multiple stages and spools is also discussed. Derived from text

N93-21316 Aeronautical Research Labs., Melbourne (Australia). **FIELD EVALUATION OF SIX PROTECTIVE COATINGS APPLIED TO T-56 TURBINE BLADES AFTER 2000 HOURS OF ENGINE USE Technical Report No. 2**

S. G. RUSSO Nov. 1992 38 p Original contains color illustrations

(ARL-TR-2; AR-007-113) Copyright Avail: Issuing Activity

The first-stage high-pressure turbine blades in RAAF T-56 engines have a rejection rate which is unacceptably high. It was revealed that the current coating, a conventional nickel aluminide, has a greater than 60 percent rejection rate after 2000 hours. Consequently, a trail program was established to assess the benefits of five alternative protective coatings and to determine which coatings, if any, could withstand up to 3000 engine operating hours. A previous report demonstrated the potential of platinum and platinum/rhodium modified aluminides after 1500 hours of engine operation. This report, after approximately 2000 hours of service, supports the previous recommendations that the precious metal aluminides offer superior resistance to hot corrosion than the conventional aluminides and chromium-modified aluminides. The inability of the silicon-modified aluminide to form an evenly distributed coating over the entire blade renders it unsuitable. Author (revised)

N93-21459# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry (France).

SUPERSONIC TRANSPORT: WHICH MATERIAL FOR THE ENGINE [TRANSPORT SUPERSONIQUE: QUELS MATERIAUX POUR LE MOTEUR]

A. LASALMONIE and P. SAILLOT (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel, France.) 1991 16 p In FRENCH Presented at AAAF 39th Salon International de Paris on Materiaux pour l'Aeronautique, Le Bourget, France, 14-23 Jun. 1991

(DS-2023; ETN-93-93393) Avail: CASI HC A03/MF A01

Materials proposed to assure the functioning of MCV99, an aircraft engine to replace that of the Concorde, are examined. The aim is that this engine should consume less fuel and cause less noise and air pollution. The principles of functioning of this engine are considered together with the material problems of supersonic engines. The resistance of nickel superalloys and high temperature composites are discussed and the specific bending strength of glass matrix composites are compared. The engine parts which will be made of the new materials are indicated. The thermal stability of composite materials, which may be used for the engine casing and fixed parts, are indicated. The creep strength of materials to be used for discs and blades at temperatures less than 600 C, for example titanium alloys, and SiC/Ti are discussed together with materials to be used at temperatures greater than 600C (nickel superalloys). The use of a nickel alloy or a SiC/Ti composite is proposed for the turbine shaft where temperatures of 500 C will be attained. ESA

N93-22034* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MULTI-HEAT ADDITION TURBINE ENGINE Patent

LEO C. FRANCISCUS, inventor (to NASA) and THEODORE A. BRABBS, inventor (to NASA) 9 Feb. 1993 7 p Filed 30 Jan. 1991 Supersedes N91-23180 (29 - 15, p 2381)

(NASA-CASE-LEW-15094-1; US-PATENT-5,184,460;

US-PATENT-APPL-SN-647902; US-PATENT-CLASS-60-226.1;

US-PATENT-CLASS-60-39.17; INT-PATENT-CLASS-F02K-3/04;

INT-PATENT-CLASS-F02K-3/08) Avail: US Patent and

Trademark Office

A multi-heat addition turbine engine (MHATE) incorporates a plurality of heat addition devices to transfer energy to air and a plurality of turbines to extract energy from the air while converting

it to work. The MHATE provides dry power and lower fuel consumption or lower combustor exit temperatures.

Official Gazette of the U.S. Patent and Trademark Office

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A93-23839

ANALYSIS OF FLIGHT FLUTTER TEST DATA

B. H. K. LEE and Z. BEN-NETICHA (National Research Council of Canada, Inst. for Aerospace Research, Ottawa) Canadian Aeronautics and Space Journal (ISSN 0008-2821) vol. 38, no. 4 Dec. 1992 p. 156-163. Research supported by DND refs

In this paper some of IAR's flight flutter analysis capabilities are presented. A method used to enhance and separate vibratory modes on the CF-5 aircraft is described. Techniques to determine frequency and damping using impulse or exponential decaying excitation forces are discussed and results obtained from an interactive computer program are given. A procedure to compute flutter parameters in the presence of turbulence or wing buffeting and separation of closely-together modes is described. The accuracy of the Leuven Measurement System for flutter analysis is discussed using an example from numerically-generated, free-decaying data with various amounts of noise added. A new flutter margin which includes structural damping and valid for a trinary flutter is described. Errors in damping and frequency measurements on the flutter margin are illustrated by an example.

Author

A93-24495#

FAILURE-ACCOMMODATING NEURAL NETWORK FLIGHT CONTROL

CHIEN HUANG, JAMES TYLOCK, STEVE ENGEL, JOHN WHITSON, and JAMES EILBERT (Grumman Corp., Bethpage, NY) Aug. 1992 9 p. AIAA, Guidance, Navigation and Control Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs (AIAA PAPER 92-4394) Copyright

A failure-accommodating neural network flight control system is studied. It consists of a baseline control system augmented with a neuro-controller, which generates compensating control in presence of deviations from the nominal performance as given by a model. The nominal control system provides basic stability and performance and it is derived from multivariable control designs. The neural control structure is examined in detail for its properties. It is shown that the neuro-controller exhibits interesting characteristics that may be used for failure-tolerant as well as failure-accommodating control. The approach taken for this neural network is similar to model-reference adaptive control since real-time adaptation is carried out. However, potential uncertainties associated with adaptive control are mostly avoided by starting the neural network with weights, which are computed a priori for specific failure configurations, sufficiently close to the optimal weights. Performance of the neural network failure-accommodating control is illustrated with simulations using a model of an advanced research aircraft.

Author

A93-24497#

PILOT CONTROL IDENTIFICATION USING MINIMUM MODEL ERROR ESTIMATION

RANDALL E. BAILEY (Arvin/Calspan Corp., Buffalo, NY) and D. J. MOOK (State Univ. of New York at Buffalo, Amherst) Aug. 1992 11 p. AIAA, Atmospheric Flight Mechanics Conference, Hilton Head Island, SC, Aug. 10-12, 1992 refs (AIAA PAPER 92-4421) Copyright

The Minimum Model Error (MME) estimation technique for noisy/uncertain modelings' optimal estimation is presently

evaluated in the case of human pilot control identification estimation. The error state estimate contains the minimum model correction required to produce a consistent state estimate. A stepwise regression technique is used in conjunction with the MME to extract a description of the error term. Computer simulations were used to empirically evaluate the proposed methodology; the process is found to be influenced by nonuniqueness properties in the regression analysis when measurement noise is present.

O.C.

A93-24737#

FURTHER ANALYSIS OF HIGH-RATE ROLLING EXPERIMENTS OF A 65 DEG DELTA WING

LARS E. ERICSSON and ERNEST S. HANFF (National Research Council of Canada, Inst. for Aerospace Research, Ottawa) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0620) Copyright

Further analysis has been performed of experimental results obtained in roll oscillation tests of a 65 deg sharp-edged delta wing at 30 deg inclination of the roll axis in order to uncover the fluid mechanical phenomena causing the unusual, highly nonlinear vehicle dynamics. It was found in an earlier analysis that in addition to the expected effect of convective flow time lag the test results show highly nonlinear effects on vortex breakdown of the oscillatory rate. The present analysis reveals that these effects are themselves influenced by convective flow time lag. As a result, the past time history of the oscillatory response can in some cases have a strong influence on the final trim condition.

Author

A93-24738#

BODY-AXIS ROLLING MOTION CRITICAL STATES OF A 65-DEGREE DELTA WING

JERRY E. JENKINS, JAMES H. MYATT (USAF, Wright Lab., Wright-Patterson AFB, OH), and ERNEST S. HANFF (National Research Council of Canada, Inst. for Aerospace Research, Ottawa) Jan. 1993 14 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by USAF, DND, and National Research Council of Canada refs (AIAA PAPER 93-0621)

Dynamic wind-tunnel test results of a 65 deg swept delta wing are reviewed. These tests involved body-axis rolling motions at moderate angles of attack in both the IAR 2 x 3 m low-speed wind tunnel and the 7 x 10 ft SARL facility at WPAFB. They included static, forced oscillation, and free-to-roll experiments with flow visualization. Multiple trim points (attractors) for body-axis rolling motions and other unusual dynamic behavior were observed. These data are examined in light of the nonlinear indicial response theory. The analysis confirms the existence of 'critical states' with respect to roll angle. When these singularities are encountered in a dynamic situation, large and persistent transients are induced. Conventional means of representing the nonlinear forces and moments in the equations of motion, notably the locally-linear model, are shown to be inadequate for these cases. Finally, the impact of these findings on dynamic testing techniques are discussed.

Author

A93-24739#

UNSTEADY AERODYNAMICS IN AIRPLANE STALL-SPIN DEPARTURE

ANDREW CRAIG and DONALD C. ROMANI, JR. (Wichita State Univ., KS) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0622) Copyright

Incorporation of unsteady aerodynamics into a mathematical model of the dynamic behavior of a general aviation airplane provided much better matching of full scale flight test results than was previously obtained. In particular, when the methods used in helicopter rotor modeling were applied to the unsteady force and moment characteristics of the wing of the aircraft, realistic damping of the oscillatory motions seen in flight resulted.

Author

A93-24740#

PARALLEL ROTORCRAFT FLIGHT SIMULATION

S. SARATHY and V. R. MURTHY (Syracuse Univ., NY) Jan. 1993 14 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0623) Copyright

This work covers the derivation, implementation, and validation of a flight simulation model, based on a Rotating Blade Element (RBE) rotor model with coupled flap, pitch, and lag blade motions. The development of a parallel version of this model, together with appropriate parallel algorithms, is discussed here. Results for the sequential and parallel implementations have been provided. The RBE formulation has been compared with results from CAMRAD for the OH-6 helicopter. The timing results from the parallel implementation, on the Encore Multimax (shared memory MIMD) parallel computer, have demonstrated speedup factors between 10 and 20 for the trim tasks. Author

A93-24743#

WIND TUNNEL TEST TECHNIQUES FOR UAV SEPARATION INVESTIGATIONS

S. A. MOYER, M. D. TALBOT, and A. HONER (U.S. Navy, Naval Air Warfare Center, Warminster, PA) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0626)

Wind tunnel tests of an unmanned aerial vehicle separating from two fighter aircraft have been conducted. UAV's present different concerns in separation testing than do conventional stores due to the presence of large lifting surfaces, physical size, and control surface effects. The planning and results of these recent investigations give several new results with respect to the separation testing of complex configurations. Conclusions are given with respect to test matrix requirements, ejector modeling, and carriage loads determination. Author

A93-26432* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ROBUST INTEGRATED FLIGHT/PROPULSION CONTROL DESIGN FOR A STOVL AIRCRAFT USING H-INFINITY CONTROL DESIGN TECHNIQUES

SANJAY GARG (NASA, Lewis Research Center, Cleveland, OH) Automatica (ISSN 0005-1098) vol. 29, no. 1 Jan. 1993 p. 129-145. refs Copyright

Results are presented from an application of H-infinity control design methodology to a centralized integrated flight/propulsion control (IFPC) system design for a supersonic STOVL fighter aircraft in transition flight. The emphasis is on formulating the H-infinity optimal control synthesis problem such that the critical requirements for the flight and propulsion systems are adequately reflected within the linear, centralized control problem formulation and the resulting controller provides robustness to modeling uncertainties and model parameter variations with flight condition. Detailed evaluation results are presented for a reduced order controller obtained from the improved H-infinity control design showing that the control design meets the specified nominal performance objective as well as provides stability robustness for variations in plant system dynamics with changes in aircraft trim speed within the transition flight envelope. Author

A93-26946

DIRECT MULTIVARIABLE ADAPTIVE CONTROLLER WITH APPLICATION TO WING FLUTTER

R. LIVNEH and G. L. SLATER (Cincinnati Univ., OH) In Adaptive control and signal processing Anaheim, CA Acta Press 1992 p. 13-17. refs Copyright

The problem of designing a robust simplified controller for control of wing flutter is studied. The adaptive control algorithm developed by Bar-Kana et al. is extended to include independent excitations to both the input and the output of the plant. Those excitations are partitioned into measurable and unmeasurable parts

and are incorporated into the ideal trajectory and into the adaptive law. Numerical simulations of the wing flutter control problem demonstrate stability and robustness over a wide range of variations in both plant and adaptation parameters. Author

A93-26948

A TREATMENT TO FLIGHT CONTROLLER NONLINEARITY EFFECTS - AN ADAPTIVE COMPENSATOR APPROACH

QUANG M. LAM (Synetics Corp., Warminster, PA) In Adaptive control and signal processing Anaheim, CA Acta Press 1992 p. 79-84. refs Copyright

This paper presents a two-fold study. It first investigates the applicability of the adaptive control theory applied to the flight control design for the UH-60A helicopter. Second, it assesses the feasibility of this adaptive control law to provide treatments to flight control nonlinearity effects. The study proposes an attractive and cost-effective design method for the control law development of the future rotorcraft whose flight control system demands higher performance and more robustness. Author

A93-27295

ACTIVE AIRCRAFT RECOVERY FROM A SPIN

[WYPROWADZANIE CZYNNIE SAMOLOTU Z KORKOCIAGU]

WIESLAW J. MICHALSKI and MARIA ZLOCKA (Politechnika Warszawska, Warsaw, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817) no. 103 1991 p. 165-168. In Polish. refs

The spin maneuver and recovery from a spin are investigated with the objective of developing an automatic spin recovery system. For this purpose, an optimal control theory is applied to the synthesis of a suboptimal control law in a nonstandard manner. V.L.

A93-27300

INVESTIGATION OF THE AIRCRAFT SPIN VIA SENSITIVITY ANALYSIS [ZASTOSOWANIE ANALIZY WRAZLIWOSCI DO BADANIA KORKOCIAGU SAMOLOTU]

MARIA ZLOCKA (Politechnika Warszawska, Warsaw, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817) no. 103 1991 p. 291-294. In Polish. refs

In the paper, the sensitivity analysis is applied to an aircraft spin investigation. For this purpose, the sensitivity functions are computed. They make it possible to determine the influence of stall parameter variations and rudder shielding on the spin. Author

A93-27604

A DATA PROCESSING AND CONTROL SYSTEM FOR COUNTERACTING WIND SHEAR [INFORMACIIONNO-UPRAVLIASHCHIAIA SISTEMA PARIROVANIIA SDVIGA VETRA]

V. M. SOLDATKIN and N. M. AMINOV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 16-20. In Russian. refs Copyright

A numerical method is proposed for developing an aircraft control algorithm for situations where wind shear is present. The approach is based on the differential game theory. A data processing and control system is described which provides for the identification and efficient counteraction of wind shear. It can also generate warning signals to allow changes in the flight regime or flight route. A schematic diagram of the system is presented. V.L.

A93-28469

WIND IDENTIFICATION ALONG A FLIGHT TRAJECTORY. II - 2D-KINEMATIC APPROACH

A. MIELE, T. WANG (Rice Univ., Houston, TX), and W. W. MELVIN (Delta Air Lines, Inc., Atlanta, GA; Air Line Pilots Association, Washington) Journal of Optimization Theory and Applications (ISSN 0022-3239) vol. 76, no. 1 Jan. 1993 p. 33-55. Research supported by Air Line Pilots Association, United States Aviation

Underwriters, and Texas Advanced Technology Program refs
Copyright

A 2D kinematic approach is presented in which the wind velocity components are computed as the difference between the inertial velocity components and the airspeed components. The accelerometer bias components and the impact velocity components are determined by matching the flight trajectory computed from digital flight data recorder data with the flight trajectory computed from air traffic control radar data. This leads to a least-square problem, which is solved analytically for both the continuous formulation and the discrete formulation. The correct identification of the accelerometer biases and the impact velocity components depends on the precision of the identified wind profile. This depends on the proper selection of the integration time. Unstable identification occurs when the integration time is too short. The proposed approach was applied to the case of Flight Delta 191. Stable identification took place for integration times in the range of 120 - 180 sec before impact. O.G.

A93-28603

MEASUREMENTS OF AERODYNAMIC ROTARY STABILITY DERIVATIVES USING A WHIRLING ARM FACILITY

MARC J. M. MULKENS and ALBERT O. ORMEROD (Cranfield Inst. of Technology, United Kingdom) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 178-183. Research supported by Ministry of Defence Procurement Executive refs
Copyright

This work is part of a program of research in which the high angle-of-attack region is of particular interest. Equipment and methods have been developed to adapt a whirling arm facility for the measurement of the effects of path curvature on two generic combat aircraft configurations. An explanation is given of the merits of using a whirling arm and some of the difficulties are mentioned. The derivatives associated with steady rotation have been assessed at angles of attack up to 30 deg. Both longitudinal and directional tests have been made and comparisons with the results of oscillatory tests are presented. For the directional results, little difference was found. The longitudinal results, however, showed a significant difference at certain high angles of attack. These differences, which were of different signs for the two models tested, have to be attributed to effects associated with the rate of change-of-incidence. Author

A93-28611

OPTIMAL TAKEOFF OF A HELICOPTER FOR CATEGORY A V/STOL OPERATIONS

YOSHINORI OKUNO (National Aerospace Lab., Tokyo, Japan) and KEIJI KAWACHI (Tokyo Univ., Japan) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 235-240. refs
Copyright

Two applications of a nonlinear optimal control theory are used to calculate the optimal control procedures for a helicopter following one engine failure during takeoff. One application is concerning the problem of optimization of the takeoff procedure for category A short-takeoff-and-landing (STOL) operation so that the required heliport size is minimized. The results show that the required takeoff distance using the normal takeoff procedure can be reduced by 30-60 percent if the takeoff path and the critical decision point are specifically optimized for a given set of the operating conditions, e.g., takeoff weight, ambient conditions, and heliport configuration. The second application concerns the problem of evaluation of the takeoff performance for category A vertical takeoff-and-landing (VTOL) operation. The calculated maximum weight for the normal takeoff path shows good agreement with the certificated takeoff weight. Additionally, optimization of the takeoff path is shown to allow increasing the payload by 10 percent. Author

A93-28613

MATHEMATICAL PHENOMENOLOGY FOR THRUST-VECTORING-INDUCED AGILITY COMPARISONS

BENJAMIN GAL-OR (Technion - Israel Inst. of Technology, Haifa) and DANIEL D. BAUMANN (USAF, Flight Dynamics Directorate, Wright-Patterson AFB, OH) *Journal of Aircraft* (ISSN 0021-8669)

vol. 30, no. 2 Mar.-Apr. 1993 p. 248-254. Research supported by General Dynamics Corp., General Electric Co., Pratt and Whitney Group, et al. refs

(Contract AF-AFOSR-89-0445)

Copyright

The recent introduction of thrust-vectoring (TV) maneuverability/controllability into fighter aircraft design methodologies requires reassessment of aircraft equations of motion, especially in the deep poststall (PST) domain. Therefore, a mathematical phenomenology has been developed in this article to assess the main components which affect TV-induced agility and PST-maneuverability. This article identifies the TV-induced forces and moments required to maximize TV control power. It then presents a number of simplified approximate equations for assessing maximized standard agility comparison maneuvers (SACOM) of separate pitch, yaw, and roll TV-induced reversal maneuvers. Such SACOMs are required to compare the performance of future different designs of tailless vectored fighters. Author

A93-28616

SIMULTANEOUS STRUCTURE/CONTROL DESIGN

OPTIMIZATION OF A WING STRUCTURE WITH A GUST LOAD ALLEVIATION SYSTEM

SHINJI SUZUKI (Tokyo Univ., Japan) and SATOSHI YONEZAWA (Kobe Steel, Ltd., Japan) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 268-274. refs
Copyright

Simultaneous design optimization is considered for structure and control parameters of a wing with a gust load alleviation (GLA) control system. The application of a goal programming (GP) formulation to the design synthesis of an aeroservoelastic system is carried out by the use of a simple mathematical model in conjunction with a wind-tunnel model having a GLA control system. Numerical applications are based on a cantilever wing having an aileron surface controlled by wing-tip accelerometer feedback signals. System equations are obtained in the form of state equations, thus enabling the statistical characteristics of both the gust-induced wing stress and the control surface deflection angle to be evaluated using their standard deviations. The wing spar height and the controller feedback gain are simultaneously optimized to obtain the minimum spar weight while satisfying the following structure and control design constraints: 1) the spar stress is limited with the control system either on or off; 2) the control surface deflection angle is restricted; and 3) system stability should be guaranteed by incorporating a controller stability margin. Numerical examples demonstrate the successful application of a GP formulation for the simultaneous structure/control design synthesis by specifying priorities to the conflicting design constraints. Author

A93-29297

AEROELASTIC SYSTEM IDENTIFICATION OF ADVANCED TECHNOLOGY AIRCRAFT THROUGH HIGHER ORDER SIGNAL PROCESSING

RONALD O. STEARMAN, E. J. POWERS (Texas Univ., Austin), JASON SCHWARTZ, and RUDY YURKOVICH (McDonnell Aircraft Co., Saint Louis, MO) *In International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 2 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 1607-1616. Research supported by Texas Advanced Technology Program and McDonnell Aircraft Co refs*
Copyright

This study investigated and modeled nonlinear aeroelastic phenomena associated with advanced technology aircraft which cannot be adequately investigated using traditional analysis and modeling techniques. The approach is based on digital nonlinear system identification procedures which utilize higher-order spectral and correlation moments. This technique was used to investigate aeroelastic limit cycle responses observed in the transonic flow regime on contemporary fighter aircraft for certain wing store configurations. An aeroelastic model of the limit cycle mechanism is proposed. Bispectral signal processing was used on time series

pressure, acceleration, and strain gauge signals on the aircraft during flight testing. Results of the higher order signal analyses supported the modeling hypothesis unlike linear signal processing results. Bispectral analysis is a useful tool for identification of quadratic nonlinearities such as parametric and combination instabilities and resonances due to mixed mode input. A.O.

A93-29351

BACKWARD BIFURCATION FOR STRUCTURAL DIVERGENCE OF A WING SECTION

SCOTT W. TENTO (Science Applications International Corp., Seattle, WA) /n Dynamics and control of large structures; Proceedings of the 8th VPI&SU Symposium, Blacksburg, VA, May 6-8, 1991 Blacksburg, VA Virginia Polytechnic Institute and State University 1992 p. 341-352. refs

In this note a wing section with a nonlinear control surface is studied in an incompressible potential flow. Structural divergence is described as steady state bifurcation, and flutter is described as an Hopf bifurcation. Stable, subcritical steady state bifurcations are characterized. Stable, subcritical bifurcation is a dangerous, nonlinear phenomenon which may affect aircraft systems.

Author

A93-29691

SELECTION OF TRANSDUCER MEASURING RANGES IN FLIGHT VEHICLE CONTROL SYSTEMS [O VYBORE DIAPAZONOV IZMERENIIA DATCHIKOV V SISTEMAKH AVTOMATICHESKOGO UPRAVLENIIA LETATEL'NYMI APPARATAMI]

G. D. KOKOREV /n Algorithms and automated techniques for the design of control systems for moving objects Moscow Izdatel'stvo Moskovskogo Aviatsonnogo Instituta 1991 p. 4-12. In Russian. refs

Copyright

An approach is proposed for selecting optimal ratios of signal limit levels for angle and angular velocity transducers, with a flight vehicle roll control system considered as an example. The approach allows for the probability of reaching the limits in the process of control. The method presented here is also applicable to the control of other coordinates of flight vehicles. Practical recommendations concerning the selection of signal limit ratios are given. V.L.

N93-19915# British Aerospace Defence, Preston (England).

IN-FLIGHT STRUCTURAL MODE EXCITATION SYSTEM FOR FLUTTER TESTING

R. B. RAMSAY /n AGARD, Flight Testing 20 p Oct. 1992 Copyright Avail: CASI HC A03/MF A04

A system for exciting the modes of vibration of an unstable digitally controlled fly-by-wire combat aircraft via the primary control actuators in order to extract flutter data is presented. The system has been developed on the Experimental Aircraft Program (EAP) to generate, within the Flight Control computers, frequency sweep and impulse excitation signals which are injected via the primary control actuators to the foreplane and wing trailing edge flaperons. The choice of surface, actuator amplitude input and symmetric or antisymmetric excitation is pilot selectable. The system will permit predefined waveforms, referred to as test routines, to be summed into the Flight Control System (FCS) actuation loops under cockpit control. Rig and aircraft ground response performance tests were performed on the foreplane and wing outboard trailing edge flaperon actuators as part of the qualification of the system. A flight test program of 15 flights measured aircraft responses due to the injection of frequency sweeps and impulses. Results are presented for the foreplane and the wing and a comparison made with predictions and previous flight flutter tests using bonker impulsive excitation. Operation of this system demonstrated the flexibility in being able to select the excitation type and input amplitudes, optimized to the aircraft configuration and flight condition, to extract high quality data, which is the key to successful flight flutter testing. Use of this system, particularly where structural limitations restrict the use of other types of excitation, offers great potential in reducing overall testing time for aircraft with a large

number of stores, provided the system is designed to have flexibility in the choice of input available to the test engineer. Author

N93-19918# National Research Council of Canada, Ottawa (Ontario).

FLY-BY VOICE, A TECHNOLOGY DEMONSTRATION

J. MURRAY MORGAN and DAVID R. STARKS (Canadian Marconi Co. Ltd., Kanata, Ontario) /n AGARD, Flight Testing 10 p Oct. 1992

Copyright Avail: CASI HC A02/MF A04

A connected word speech recognizer was mounted in the Flight Research Laboratory's Bell 205 Airborne Simulator (variable stability helicopter) and used to generate direct voice control over the aircraft's trajectory. The purpose of this exercise was to demonstrate the feasibility of sufficiently accurate speech recognition in the helicopter cockpit environment to permit free use of the technology in this situation. It was not intended to postulate that primary flight control should be achieved by voice command alone. Integration of the Speech Recognizer in the cockpit proved not to be a trivial task, it was necessary to investigate and correct various technical errors in the aircraft's audio system, to modify the machine's power conversion system significantly and to deal with both inductive and audio pick-up. To enable the aircraft to be controlled adequately by the inherently low frequency voice command it was necessary to design and implement a suite of advanced control systems which could blend and switch between themselves as needed without pilot intervention and without producing aircraft behaviors which would cause the pilot concern regarding the safety of his aircraft. This paper describes the processes involved in Speech Recognizer integration and control word system development and concludes that connected speech recognition is viable as a useful and realizable adjunct to the advanced helicopter cockpit. Author

N93-19960*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

GUIDANCE AND FLIGHT CONTROL LAW DEVELOPMENT FOR HYPERSONIC VEHICLES Progress Report No. 3, 5 Jul. 1992 - 31 Jan. 1993

A. J. CALISE and N. MARKOPOULOS Jan. 1993 41 p (Contract NAG1-1257)

(NASA-CR-192102; NAS 1.26:192102) Avail: CASI HC A03/MF A01

During the third reporting period our efforts were focused on a reformulation of the optimal control problem involving active state-variable inequality constraints. In the reformulated problem the optimization is carried out not with respect to all controllers, but only with respect to asymptotic controllers leading to the state constraint boundary. Intimately connected with the traditional formulation is the fact that when the reduced solution for such problems lies on a state constraint boundary, the corresponding boundary layer transitions are of finite time in the stretched time scale. Thus, it has been impossible so far to apply the classical asymptotic boundary layer theory to such problems. Moreover, the traditional formulation leads to optimal controllers that are one-sided, that is, they break down when a disturbance throws the system on the prohibited side of the state constraint boundary. Author

N93-20039*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

APPARATUS AND METHOD FOR IMPROVING SPIN RECOVERY ON AIRCRAFT Patent Application

H. PAUL STOUGH, II, inventor (to NASA) 21 Sep. 1992 13 p (NASA-CASE-LAR-14747-1; NAS 1.71:LAR-14747-1;

US-PATENT-APPL-SN-948057) Avail: CASI HC A03/MF A01

Previous research on airplane spinning and recovery has shown that at potential spin conditions (high angles of attack with rotation) the horizontal tail, depending upon its location, can create a wake about the vertical tail and rudder which can adversely affect airplane spin and recovery characteristics. Many methods of altering the tail geometry to modify these interference effects have been investigated for improving airplane spin and recovery

characteristics. Examples of changes includes relocation of the horizontal tail, increasing control surface travel, and use of a 'flip tail' that can be rotated to extreme angles for spin recovery. A device is provided which improves the spin recovery characteristics of aircraft which involves attaching the horizontal tail of the aircraft to the aircraft such that a gap remains between the root end of each horizontal tail section and the fuselage or vertical tail of the aircraft. The gaps measure between about 15 and 30 percent of the tail semispan. The gaps may be covered by shields which are released should a spin occur. NASA

N93-20296*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

RESEARCH IN ROBUST CONTROL FOR HYPERSONIC VEHICLES Progress Report No. 1, 1 Jul. - 30 Nov. 1992

A. J. CALISE and H. BUSCHEK Nov. 1992 45 p
(Contract NAG1-1451)
(NASA-CR-192127; NAS 1.26:192127) Avail: CASI HC A03/MF A01

During the first reporting period research concentrated on finishing the modeling work required for a representative model of a scramjet propulsion system for hypersonic vehicles. An existing hypersonic propulsion code was adjusted to the winged-cone configuration. In this process the complete force and moment calculation was revised. The advantageous feature of the code to account for angle of attack variations was then used to compute the thrust, lift, and pitching moment contributions of the propulsion system not only for various Mach numbers and fuel equivalence ratios, but also for different angles of attack. Author

N93-20551# Wright Lab., Wright-Patterson AFB, OH.

URV FLIGHT TEST OF AN ADA IMPLEMENTED SELF-REPAIRING FLIGHT CONTROL SYSTEM Final Report, 1 Jan. 1985 - 31 Aug. 1992

MARK J. MEARS, STAN PRUETT, and JOHN HOUTZ Aug. 1992 124 p
(Contract AF PROJ. 2403)
(AD-A259205; WL-TR-92-3101) Avail: CASI HC A06/MF A02

Self-Repairing Flight Control System (SRFCS) technology is an extension of traditional redundancy management. It uses existing redundancy in aircraft control surfaces to compensate for control surface failures and battle damage effects. The results of flight tests of a SRFCS, coded in Ada for an Unmanned Research Vehicle (URV) is described. This includes a description of the design of the control reconfiguration method, the Failure Detection (FDI) method, the Ada code, the URV model, data analysis of the flight test time histories, and the computational aspects of the algorithms. Time history plots of selected flight test results are included and acceptable performance was achieved for all the failure cases which were flown. GRA

N93-20596# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

FAILURE IDENTIFICATION USING MULTIPLE MODEL ADAPTIVE ESTIMATION FOR THE LAMBDA FLIGHT VEHICLE M.S. Thesis

PETER D. HANLON 4 Dec. 1992 93 p
(AD-A259137; AFIT/GE/ENG/92D-19) Avail: CASI HC A05/MF A01

This study develops and investigates the performance of a Multiple Model Adaptive Estimator (MMAE) to detect and identify control surface and sensor failures on the LAMBDA flight vehicle (a URV developed by Wright Laboratories). The MMAE uses a bank of Kalman filters that predict the aircraft response to a given input, with each filter model based on a different failure hypothesis, and then forms the residual difference between the prediction and sensor measurements for each filter. The MMAE uses these residuals to determine the probabilities of the failures that are modeled by the Kalman filters. Initially the MMAE identified all these failures within 4 seconds of onset. Various performance improvement techniques were researched and the identification time was reduced to less than 2 seconds after failure onset. This improvement was mostly due to an increase in the penalty for

measurement differences and through returning of the Kalman filters. The MMAE performance was tested at the boundaries of the LAMBDA flight envelope, with good performance found at points close to the design flight condition. The performance at points that were far from the design flight condition indicates that gain scheduling is required to provide adequate performance across the entire envelope. GRA

N93-20628# National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.

FLUID/STRUCTURES INTERACTIONS. AIRCRAFT CONSIDERATIONS

B. H. K. LEE In Manitoba Univ., Proceedings of the Thirteenth Canadian Congress of Applied Mechanics p 120-122 May 1991 Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

The Institute of Aerospace Research (IAR) has an active ongoing program in aeroelastics. This paper describes research being conducted on buffeting and on flutter of aircraft structures. Buffeting is almost always encountered when an aircraft approaches the limit of usable lift at high speeds thus limiting the maneuverability of the aircraft. Methods of predicting the buffet intensity as the aircraft penetrates into the buffet regime are very useful in aircraft design. A model was developed which analyzes the coupling between the structural vibration and aerodynamics of the oscillating wing. A procedure used in calculating the response of a wing to random loading with aerodynamics is discussed. The methodologies, models, and computer codes used in flutter analysis procedures are described. The commercial MSC/NASTRAN finite element structural analysis program is used in calculation of the mode shapes. A three dimensional computer code capable of modeling complex aircraft configurations is used to model the unsteady aerodynamic forces. A flutter code was developed at IAR which has the capability of performing analyses at subsonic, transonic, and supersonic speeds. Author (CISTI)

N93-20743# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

A SIMULATOR STUDY INTO LOW SPEED LONGITUDINAL HANDLING QUALITIES OF ACT TRANSPORT AIRCRAFT Final Report

W. P. DEBOER, J. A. J. VANENGELLEN, H. T. HUYNH (Office National d'Etudes et de Recherches Aérospatiales, Paris, France), O. P. NICHOLAS (Royal Aerospace Establishment, Farnborough, England), and D. SCHAFFRANEK (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany) 1 Jul. 1990 175 p
(NLR-TP-89387-U; GARTEUR/TP-055; ETN-92-92856) Avail: CASI HC A08/MF A02

The acceptability to pilots of changes in transport aircraft handling qualities, due to failure from a sophisticated primary Flight Control System (FCS), to a simpler backup system with different but good characteristics, was assessed. The study was undertaken in a flight simulator. Work concentrated on longitudinal control on the landing approach, with particular emphasis on the change in handling qualities which might occur in reverting to backup control system. The results are presented, together with some general guidelines. Tentative measures are proposed, to predict the handling qualities of flight path control systems, and to predict the magnitude of the change in handling qualities in switching from one control system to another. ESA

N93-21197*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CONTROLLER PARTITIONING FOR INTEGRATED FLIGHT/PROPULSION CONTROL IMPLEMENTATION

SANJAY GARG Feb. 1993 28 p Presented at the American Control Conference, Chicago, IL, 24-26 Jun. 1992; sponsored by the AACC

(Contract RTOP 505-62-50)
(NASA-TM-105804; E-7234; NAS 1.15:105804) Avail: CASI HC A03/MF A01

The notion of partitioning a centralized controller into a

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decentralized, hierarchical structure suitable for integrated flight/propulsion control (IFPC) implementation is discussed. A systematic procedure is developed for determining partitioned airframe and engine subsystem controllers (subcontrollers), with the desired interconnection structure, that approximate the closed-loop performance and robustness characteristics of a given centralized controller. The procedure is demonstrated by application to IFPC design for a Short Take-Off and Vertical Landing (STOVL) aircraft in the landing approach to hover transition flight phase.

Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A93-23840

AIRCRAFT TAKE-OFF LABORATORY SIMULATION FOR DE/ANTI-ICING STUDY

JEAN-LOUIS LAFORTE, GILLES BOUCHARD, and PATRICK LOUCHEZ (Quebec Univ., Chicoutimi, Canada) Canadian Aeronautics and Space Journal (ISSN 0008-2821) vol. 38, no. 4 Dec. 1992 p. 183-193. Research supported by Union Carbide Canada, Inc. and Univ. du Quebec refs

Experimental procedures to simulate take-off conditions are described which were aimed at evaluating the behavior of de/anti-icing fluids on the airfoil surface and determining the impact of these fluids on the aerodynamics of the model. Calibration and development tests were carried out with the cruise airfoil model in the laboratory. Results confirmed the existence of a significant lift loss at all rotation angles. This phenomenon was found to be similar to that of a roughness element, placed at the leading edge of the wing model, and to be dependent on the presence of a fluid wave moving after rotation from underneath the wing leading edge. De-icing fluids appear to exhibit lower lift loss than anti-icing fluids.

O.G.

A93-24033

ON EXPERIMENTAL STUDY OF 3-D FLOW IN SELF-CORRECTING WIND TUNNEL

PEICHU ZUO, JIAJU HE, HUAXING LI, and MIN XU (Northwestern Polytechnical Univ., Xian, China) Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 11, no. 1 Jan. 1993 p. 79-84. In Chinese. refs

A test section for conducting 3D model test in a 2D low-speed flexible wall self-correcting wind tunnel has been designed and constructed. A satisfactory solution to the problem of insufficient wall adjustment to the 3D model tests has been found. Two computer programs needed for the tests have been developed based on Wedemeyer's theory. Preliminary success was achieved in a half-model test. Adaptive wall tests were conducted on two wing-body models for blockages of 3.1 and 5.5 percent and one half-model wing for 4.5 percent blockage. The results are in fairly good agreement with those of tests on the same models performed in 3D wind tunnels 10-30 times the size of the adaptive wall test section. The test results indicate that the design and construction of the test section, the completed computer program, and the test technique are all successful.

C.D.

A93-24481#

THE STRUCTURE AND MATERIAL TESTING FACILITY NEEDED FOR FUTURE SST/HST DEVELOPMENT

TAKASHI UGAI, HIROSHIGE KIKUKAWA (Fuji Heavy Industries, Ltd., Utsunomiya, Japan), YOSHIKI IWASAWA (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan), SHOJI MAEKAWA (Kawasaki Heavy Industries, Ltd., Kakamigahara, Japan), and TOSHIHIRO KAWASHIMA (Ishikawajima-Harima Heavy Industries Co., Ltd.,

Tokyo, Japan) Jul. 1992 9 p. AIAA, Aerospace Ground Testing Conference, 17th, Nashville, TN, July 6-8, 1992

(AIAA PAPER 92-3887) Copyright

A conceptual development status evaluation is presented for prospective SST/HST aircraft materials and structures. A major possibility for the reduction of testing time is a material-specimen testing facility that can simultaneously handle 600 coupons. The configuration and additional performance capabilities of such a facility are discussed.

O.C.

A93-24874#

SUGGESTIONS FOR DEVELOPMENT OF THREE-PHASE 60 HZ ARC HEATED WIND TUNNELS

HORACIO A. TRUCCO (General Applied Science Labs., Inc., Ronkonkoma, NY) Jan. 1993 9 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0795) Copyright

This paper explores and suggests possibilities for designing more efficient and less costly arc heated wind tunnels by directly feeding the electric energy from a 60 Hz three-phase utility line. It is shown that a three-phase supplied arc heater is operationally feasible and that enhancement in energy conservation efficiency can be substantial. A specific design concept is offered.

R.E.P.

A93-24876#

DEVELOPMENT OF POLYTECHNIC UNIVERSITY'S SUPERSONIC WIND TUNNEL FACILITY

IRAJ M. KALKHORAN, ROBERT J. CRESCI, and PASQUALE M. SFORZA (Polytechnic Univ., Brooklyn, NY) Jan. 1993 5 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993

(AIAA PAPER 93-0798) Copyright

To prepare for the long-term requirement for supersonic experimentation training and research Polytechnic University is proceeding with a program of expanding and upgrading their high speed facilities. The present Mach 3 wind tunnel has been replaced with a Mach 1.75 to 4.0, 15 x 15 in. wind tunnel. The new facility and its capabilities for the educational and research needs of the university, and of industry are described.

R.E.P.

A93-25518#

TRENDS IN INTERNATIONAL AEROSPACE GROUND TEST FACILITIES

D. C. DANIEL and A. H. BOUDREAU (USAF, Arnold Engineering Development Center, Arnold AFB, TN) Jan. 1993 26 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0348)

Six classes of major aerospace facilities are subjected to a comparative evaluation: wind tunnels, air-breathing propulsion altitude test cells, rocket propulsion altitude test cells, space chambers, aeroballistic hypervelocity ranges, and arc-heated facilities. These facilities are located in Europe, Russia, Japan, and the U.S. Most major wind tunnels are noted to be at least 20 years old. Two of the most productive facilities are the result of international collaboration in both financing and management.

O.C.

A93-27294

MODELING AND ANALYSIS OF THE WINCH LAUNCH OF A GLIDER [MODELOWANIE I ANALIZA STARTU SZYBOWCA ZA POMOCĄ WYCIAGARKI]

JERZY MARYNIAK and PIOTR KONOPKA (Politechnika Warszawska, Warsaw, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817) no. 103 1991 p. 157-160. In Polish. refs

Results of the physical and mathematical modeling of the winch launch of a glider are reported. For a specific launch example, calculations are made of the line length and launch velocity. Results are presented in graphic form.

V.L.

A93-27395

NEW SLANT VISUAL RANGE MEASURING DEVICE PROMISES IMPROVED AIRPORT OPERATIONS

JUERGEN STREICHER (DLR, Inst. fuer Optoelektronik, Oberpfaffenhofen, Germany), CHRISTOPH MUENKEL (Hagenuk GmbH, Hamburg, Germany), and HEINRICH BORCHARDT (German Meteorological Service, Hamburg, Germany) ICAO Journal (ISSN 0018-8778) vol. 47, no. 12 Dec. 1992 p. 14-16.

Copyright

An eye-safe laser-based lidar system installed at Hamburg Airport has demonstrated its ability to accurately measure the visibility, or 'runway visual range' (RVR) that is apparent to a pilot during a landing approach. The lidar echo is evaluated by applying the Klett algorithm, and the visibility is then calculated by means of the Koschmieder relation; the same relation is used to assess RVR by means of the transitometer, although in this case it is applied to a slanted path. The new lidar allows a more economical use of a single sensor. O.C.

A93-27396

WIND SHEAR ALERT SYSTEM BRINGS SAFETY IMPROVEMENTS TO MAJOR U.S. AIRPORTS

JON BROWN (Loral Data Systems, Sarasota, FL) ICAO Journal (ISSN 0018-8778) vol. 47, no. 12 Dec. 1992 p. 17-20.

Copyright

The FAA has instituted a campaign to equip 110 U.S. airports with a low level windshear alert system (LLWAS) and Doppler radar. Attention is presently given to the implementation of Phase-3 LLWAS; these installations can possess as few as nine sensors (Washington National Airport) to 29 (Denver International), depending on the severity of the threat. The Phase-3 LLWAS ribbon display terminal presents runway-oriented information, rather than discrete sensor information. O.C.

A93-27477

AERONAUTICAL TECHNOLOGIES AND COMMUNICATIONS - TOWARD ADVANCED TECHNOLOGY PASSENGER TERMINALS [TECNICA Y COMUNICACIONES AEREAS - HACIA LOS TERMINALES DE PASAJEROS CON TECNOLOGIA AVANZADA]

MARCOS GARCIA GRUZADO (Madrid, Univ. Politecnica, Spain) Ingenieria Aeronautica y Astronautica (ISSN 0020-1006) no. 330 1993 p. 28-31. In Spanish.

Copyright

The current plans for further development of Munich airport and Madrid's Barajas airport are presently discussed as paradigmatic instances of state-of-the-art airport design incorporating advanced passenger accommodating technologies. These novel technologies allow highly automated ticket purchase, luggage handling, and customs-related activities. O.C.

A93-27904

HIGH-PERFORMANCE AIRCRAFT PROPULSION RESEARCH

Aerospace Engineering (ISSN 0736-2536) vol. 13, no. 2 Feb. 1993 p. 15-20.

Copyright

The NASA Lewis High Performance Aircraft Propulsion Research program aimed at developing STOVL and high-maneuverability capabilities for fighter aircraft is reviewed. Both wind tunnel and flight experiments are used to obtain steady-state and dynamic data, and CFD codes to conduct analyses. Emphasis is placed on the NASA Inlet Experiments part of the High Alpha Technology Program, which is aimed at developing inlet technology to provide high performance and stability of the propulsion system during aircraft maneuvers at high angles of attack. Topics discussed include integrated flight-propulsion controls concepts for supersonic STOVL, hot-gas injection and ground environment, vertical lift systems, and STOVL augmentors. O.G.

A93-28491

ADVANCES IN THE DESIGN OF JET ENGINE TEST FACILITIES FOR MILITARY AIRCRAFT IN AUSTRALIA

LOUIS A. CHALLIS /n Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 613-616. refs
Copyright

Advances made in the aerodynamic and related acoustical performance of formal jet engine test facilities over the past 50 years are examined, with emphasis on progress in such technology in Australia, primarily as a result of the introduction of the new F/A-18 Tactical Defense Aircraft. The Avalon F/A-18 Aircraft Run-Up facility was the first Australian facility of its type in which the design required the booth to be able to withstand an exploding engine directly in front and also to provide internal noise levels of less than 60 d/B(A) with stringent LF criteria. These performance requirements were achieved through the adoption of a steeply sloping front, careful selection of triple glazing, isolated internal floating inner structure, and the adoption of an unusual ventilation system capable of withstanding the shock waves and associated high acoustical energy generated by the primary acoustical lobe of the engine's discharge components. The Avalon facility achieves noise levels of below 45 dB(A) when exposed to noise levels in excess of 154 dB(A) at the face of the booth. C.A.B.

A93-29281* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

MODELING AND CONTROL DESIGN OF A WIND TUNNEL MODEL SUPPORT

DAVID A. HOWE (NASA, Ames Research Center, Moffett Field, CA) /n International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 2 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 866-872. Previously announced in STAR as N91-14540

Copyright

The 12-Foot Pressure Wind Tunnel at Ames Research Center is being restored. A major part of the restoration is the complete redesign of the aircraft model supports and their associated control systems. An accurate trajectory control servo system capable of positioning a model (with no measurable overshoot) is needed. Extremely small errors in scaled-model pitch angle can increase airline fuel costs for the final aircraft configuration by millions of dollars. In order to make a mechanism sufficiently accurate in pitch, a detailed structural and control-system model must be created and then simulated on a digital computer. The model must contain linear representations of the mechanical system, including masses, springs, and damping in order to determine system modes. Electrical components, both analog and digital, linear and nonlinear must also be simulated. The model of the entire closed-loop system must then be tuned to control the modes of the flexible model-support structure. The development of a system model, the control modal analysis, and the control-system design are discussed. Author

A93-29282

SIGNAL PROCESSING AND SYSTEM IDENTIFICATION TECHNIQUES FOR FLUTTER TEST DATA ANALYSIS

H. VAN DER AUWERAER, K. ISHAQUE, and J. LEURIDAN (LMS International, Louvain, Belgium) /n International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 2 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 873-883. refs

Copyright

Flutter test data analysis is essentially a linear system identification problem. However, the specific nature of the flutter test procedure requires that the system identification approach, as used in standard modal analysis, has to be complemented with particular signal processing, parameter estimation, and data presentation functionalities. Typical characteristics of flutter test data include: short time records, high environmental noise levels due to the presence of turbulence, and the fact that the system inputs may or may not be measurable and/or, are poorly controllable. Specific data processing techniques such as the Chirp-Z transform, Maximum Entropy and ARMA power spectra estimation, Maximum Likelihood system identification and

autocorrelation parameter estimation methods can be applied to improve and enable the extraction of the relevant flutter parameters. An additional requirement is for the possibility to perform the analysis on-line, with the measurement procedure enabling a quick, preliminary, data assessment, as well as an indication of the frequency and damping trends, before the next test condition is imposed. Author

N93-19456*# North Carolina Agricultural and Technical State Univ., Greensboro. Human-Machine Systems Engineering Group. **FLIGHT SIMULATOR FOR HYPERSONIC VEHICLE AND A STUDY OF NASP HANDLING QUALITIES** CELESTINE A. NTUEN, EUI H. PARK, JOSEPH M. DEEB, and JUNG H. KIM *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 8 p 12 Dec. 1992 Avail: CASI HC A02/MF A03

The research goal of the Human-Machine Systems Engineering Group was to study the existing handling quality studies in aircraft with sonic to supersonic speeds and power in order to understand information requirements needed for a hypersonic vehicle flight simulator. This goal falls within the NASA task statements: (1) develop flight simulator for hypersonic vehicle; (2) study NASP handling qualities; and (3) study effects of flexibility on handling qualities and on control system performance. Following the above statement of work, the group has developed three research strategies. These are: (1) to study existing handling quality studies and the associated aircraft and develop flight simulation data characterization; (2) to develop a profile for flight simulation data acquisition based on objective statement no. 1 above; and (3) to develop a simulator and an embedded expert system platform which can be used in handling quality experiments for hypersonic aircraft/flight simulation training. Author

N93-19706# Concordia Univ., Montreal (Quebec). Dept of Mechanical Engineering. **USE OF MICROPROCESSOR-BASED SIMULATOR TECHNOLOGY AND MEG/EEG MEASUREMENT TECHNIQUES IN PILOT EMERGENCY-MANOEUVRE TRAINING** J. V. SVOBODA, RUTH M. HERON (Transportation Development Centre, Montreal, Quebec), and H. WEINBERG (Simon Fraser Univ., Burnaby, British Columbia) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques 7 p Sep. 1992 Copyright Avail: CASI HC A02/MF A04

This paper shows how a combination of microprocessor-based simulator technology and magnetoencephalographic/electroencephalographic (MEG/EEG) techniques is being used in a program of research focussing on the effectiveness of training in precision flying in order to prepare general aviation pilots for emergency situations during take-off and landing. The simulator, representative of a light twin-engine aircraft, affords safe low-cost experimentation. Evoked potentials, obtained with application of MEG/EEG techniques and interpreted within the context of an information-processing model, are expected to add significantly to information obtained from conventional measures of performance and workload. The basic procedure in the series of studies in question involves exposure of experimental groups to simulator-generated formation flying scenarios, with instructions to follow the 'lead' pilot: in subsequent test scenarios requiring take-off and landing under engine failure and turbulent conditions, the performance of experimentals will be compared with that of controls. The paper concludes with a discussion of the safety implications of outcomes for general, military, and commercial aviation. Author

N93-20255*# Texas A&M Univ., College Station. Aerospace Engineering Div. **FLIGHT VALIDATION OF A PULSED SMOKE FLOW VISUALIZATION SYSTEM Final Report** DONALD T. WARD and KENNETH M. DORSETT Feb. 1993 44 p

(Contract NAG2-651)
(NASA-CR-192272; NAS 1.26:192272; TEES-AERO-TR-93-1)
Avail: CASI HC A03/MF A01

A flow visualization scheme designed to measure vortex fluid dynamics on research aircraft was validated in flight. Strake vortex trajectories and axial core velocities were determined using pulsed smoke, high speed video images, and semi-automated image edge detection hardware and software. The smoke was pulsed by using a fast-acting three-way valve. The valve shuttle was redesigned by NASA engineers after it repeatedly jammed in flight. The new shuttle operated flawlessly during the last two tests in the series. A 25 percent scale gothic strake, similar in shape to the leading edge extension (LEX) on an F/A-18 aircraft, was used to generate vortex over the wing of a GA-7 Cougar. The strake was operated at a local angle of attack of 22 deg and a Reynolds number of approximately 7.8×10^5 per foot. The maximum axial velocities measured in the vortex core were between 1.75 and 1.95 times the freestream velocity. The experimental measurements were in good agreement with previously published data and predictions. Analysis of the pulsed smoke system's effect on forebody vortices indicates that the system may reorient the forebody vortex system, but that the blowing momentum coefficients normally used will have no appreciable effect on the LEX vortex system. It is recommended that a similar pulsed smoke system be installed on the F/A-18 High Angle Research Vehicle and that this approach be used to analyze vortex core dynamics during the remainder of its high angle of attack research flights. Author

N93-20312*# Hampton Univ., VA. Dept. of Engineering. **EVALUATION OF CANDIDATE WORKING FLUID FORMULATIONS FOR THE ELECTROTHERMAL - CHEMICAL WIND TUNNEL Status Report** JALE F. AKYURTLU and ATES AKYURTLU 31 Oct. 1991 18 p (Contract NAG1-767) (NASA-CR-192196; NAS 1.26:192196) Avail: CASI HC A03/MF A01

Various candidate chemical formulations are evaluated as a precursor for the working fluid to be used in the electrothermal hypersonic test facility which was under study at the NASA LaRC Hypersonic Propulsion Branch, and the formulations which would most closely satisfy the goals set for the test facility are identified. Out of the four tasks specified in the original proposal, the first two, literature survey and collection of kinetic data, are almost completed. The third task, work on a mathematical model of the ET wind tunnel operation, was started and concentrated on the expansion in the nozzle with finite rate kinetics. Author

N93-20576# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering. **A SYNTHETIC ENVIRONMENT FLIGHT SIMULATOR: THE AFIT VIRTUAL COCKPIT M.S. Thesis** JOHN C. SWITZER Dec. 1992 54 p (AD-A259220; AFIT/GCS/ENG/92D-17) Avail: CASI HC A04/MF A01

This thesis describes the design and implementation of a part of the Virtual Cockpit: a synthetic environment, distributed network flight simulator. The goal of the project was to prove the concept that this type of flight simulator could fill the gap between high-end, very expensive flight simulators and low-end game quality flight simulators. The following topics are discussed: object-oriented design techniques, multi-processor utilization, the flight dynamics model, synthetic environment technology, the frame-rate vs. realism issue, and the interfaces to a realistic joystick and throttle. GRA

N93-21268# Dayton Univ. Research Inst., OH. **MEASUREMENT OF MODULATION TRANSFER FUNCTIONS OF SIMULATOR DISPLAYS Final Report, Oct. 1989 - Dec. 1990** GEORGE R. KELLY Dec. 1992 32 p (Contract F33615-90-C-0005) (AD-A259401; AL-TP-1992-0056) Avail: CASI HC A03/MF A01

The theory and methodology necessary for measuring the Modulation Transfer Function (MTF) of flight simulator displays is presented. The mathematical development of the MTF from linear system theory is outlined. The two primary methods for measuring MTF, namely the direct and indirect methods, are described and compared. The implementation of the indirect method is described in detail including measurement of the line spread function of a display, calculation of MTF from the line spread function, and calibration of the resulting MTF. The MTF's of various simulator display components and displays were measured with the indirect method and presented in graphical form. Some of the more interesting characteristics of each MTF are discussed. GRA

N93-21406# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.

REVIEW OF INITIAL EXPERIMENTS USING THE HAWK MODEL, DYNAMIC RIG FACILITY, AND THE CED 1401 DIGITAL DATA ACQUISITION EQUIPMENT Quarterly Report No. 7

H. A. HINDS and M. V. COOK Jul. 1990 30 p Sponsored by RAE

(CRANFIELD-AERO-9017; ISBN-1-871564-41-7; ETN-93-93553)

Avail: CASI HC A03/MF A01; Cranfield Inst. of Tech., Coll. of Aeronautics, Cranfield, Bedford MK43 0AL, England, HC

Work towards an ongoing program of research to evaluate the use of a Modified Stepwise Regression (MSR) procedure to predict aircraft stability and control derivatives is presented. The calibration of the control surface angles, the data acquisition system, and the measurement of moments of inertia are described. Testing of the MSR FORTRAN 77 program using data from the inertia experiments is discussed. The initial experimentation with the dynamic rig enabled the data acquisition system to be tested and improved. Various computer routines for the smoothing of data and the subsequent formatting of recorded data are in place. Geometrical definitions were sorted out and measured on the model and control surface angle calibrations were completed. The moments of inertia of the model were estimated, along with various aerodynamic damping derivatives. Objectives for the new quarter are given. ESA

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A93-24478#

PULSED DETONATION ENGINE EXPERIMENTAL AND THEORETICAL REVIEW

SHMUEL EIDELMAN and WILLIAM GROSSMANN (Science Applications International Corp., McLean, VA) Jul. 1992 17 p. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992 Research supported by DARPA refs

(Contract N66001-88-D-0088; F49620-89-C-0087)

(AIAA PAPER 92-3168) Copyright

A Review of past and current research on pulsed detonation engine devices connects early experimental work originating with the VI pulsejet to recent interest in such propulsion devices. The recent interest has been, in part, stimulated by Aviation Week where sightings of aircraft contrails lead to question if some sort of PDE device has already been developed. This review summarizes what is known about PDEs, makes predictions for applications to realistic flight vehicles including missiles and full scale aircraft, and outlines what is yet required for successful PDE development. Author

A93-24479#

ROCKET ENGINE VERSUS JET ENGINE COMPARISON

CLAUS J. MEISL (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) Jul. 1992 16 p. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992 refs

(AIAA PAPER 92-3686) Copyright

Results of a comparative investigation are presented which analyzed the commonalities and differences of liquid propellant booster rocket engines and airbreathing engines for military, high performance aircraft. The investigation covered: (1) physical environment and design requirements, (2) production costs, (3) reliability parameters, (4) maintenance characteristics and (5) the relationship of ownership and life cycle costs. Results showed that in spite of the large differences in internal physical environment and design requirements, production costs of jet engines and gas generator cycle rocket engines are similar when compared at the same engine weight and production quantity. Reliabilities of the two different engine types are similar when compared on a per mission basis. The relationship between ownership and acquisition costs is almost identical. Maintenance and overhaul costs for jet engines are much lower than those for rocket engines, due to the much higher mission rates and the more benign internal environment of jet engines. Author

A93-24744#

FLIGHT PERFORMANCE OF HYPERSONIC MINOR CIRCLE TURNING MANEUVERS

D. T. JOHNSON (USAF, Wright Lab., Wright-Patterson AFB, OH) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs

(AIAA PAPER 93-0627)

The equations for minor circle turning are developed by splitting the rate of change of the heading angle with time into that produced by an unperturbed trajectory plus that produced by aerodynamic turning, and equating the two parts. The study concentrates on minor circle turning (turning along an earth minor circle such as a latitude line), focusing all the turning energy into node rotation. Expressions for altitude, specific range, turn angle, load factor, propulsion, and L/D effects are developed. Range and turn efficiencies were found to be direct functions of L/D and $I(sp)$. Applying generic achievable hypersonic L/D and air-breathing propulsion assumptions enhanced the relative turn efficiencies at the lower hypersonic speeds, especially at the higher turn latitudes. Significant turning potential was shown with moderate load factor and thrust requirements. The generalized turning equations developed are applicable to all speed regimes, and the analysis provides some insights into potential applications. Author

A93-24915*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

NATURAL ENVIRONMENT APPLICATION FOR NASP-X-30 DESIGN AND MISSION PLANNING

D. L. JOHNSON, C. K. HILL (NASA, Marshall Space Flight Center, Huntsville, AL), S. C. BROWN (Universities Space Research Association, Huntsville, AL), and G. W. BATTS (New Technology, Inc., Huntsville, AL) Jan. 1993 6 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993

(AIAA PAPER 93-0851) Copyright

The NASA/MSFC Mission Analysis Program has recently been utilized in various National Aero-Space Plane (NASP) mission and operational planning scenarios. This paper focuses on presenting various atmospheric constraint statistics based on assumed NASP mission phases using established natural environment design, parametric, threshold values. Probabilities of no-go are calculated using atmospheric parameters such as temperature, humidity, density altitude, peak/steady-state winds, cloud cover/ceiling, thunderstorms, and precipitation. The program although developed to evaluate test or operational missions after flight constraints have been established, can provide valuable information in the design phase of the NASP X-30 program. Inputting the design values as flight constraints the Mission Analysis Program returns the probability of no-go, or launch delay, by hour by month. This

output tells the X-30 program manager whether the design values are stringent enough to meet his required test flight schedules.

Author

A93-25355

NASP - WAVERIDERS IN A HYPERSONIC SKY. I

DAVID BAKER Air International (ISSN 0306-5634) vol. 44, no. 1 Jan. 1993 p. 8-13.

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A development history is presented for the hydrogen-fueled, airbreathing (scramjet) engine-propelled National Aerospace Plane (NASP), which will be able to cruise endoatmospherically at hypersonic speeds or rise exoatmospherically, by converting to rocket power, to LEO. Attention is given to the technology-development and configuration-validation services that the X-30 project will render the far larger NASP vehicle; the configurational and propulsion system factors in question encompass the use of 'slush' hydrogen fuel, the integration of engine inlets into the aircraft forebody and exhaust nozzles into the afterbody, and the conversion from turbojet or rocket propulsion to scramjet mode and back. O.C.

A93-25359

NASP - WAVERIDERS IN A HYPERSONIC SKY. II

DAVID BAKER Air International (ISSN 0306-5634) vol. 44, no. 2 Feb. 1993 p. 96-102.

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A development status and technology readiness evaluation is presented for the X-30, in whose design aggressive use of CFD for investigation of hypersonic aerothermodynamics, and experimental searches for high specific strength refractory materials, have been of central importance. Manufacturing, handling, and assembly factors figure vitally in structural material selection for both airframe and propulsion system components. Attention is given to prospective propulsion cycles capable of efficient operation in several (acceleration, supersonic, hypersonic, exoatmospheric) regimes, such as the rocket/scramjet/ramjet/air-augmented system and the liquid air-cycle engine. O.C.

A93-25965* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

BIPS TURBOALTERNATOR-COMPRESSOR CHARACTERISTICS AND APPLICATION TO THE NASA SOLAR DYNAMIC GROUND DEMONSTRATION PROGRAM

PETER C. AMUNDSEN and WILLIAM B. HARPER, JR. (Allied-Signal Aerospace Co., Tempe, AZ) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 2 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 2.239-2.244. Research supported by NASA refs

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The NASA-sponsored 2kW(e) Solar Dynamic Space Power System Ground Test Demonstration Program requires the physical and the thermodynamic integration of the Brayton Isotope Power System (BIPS) Turboalternator-Compressor (TAC) and recuperator with a heat receiver, solar concentrator, and radiator based on Space Station Freedom designs. The aim of the designs is to provide a cost-effective, minimal-risk, viable ground test system. This paper describes the BIPS TAC configuration and performance characteristics along with the cycle analysis of BIPS TAC. C.D.

A93-25993

DESIGN OF A HYDROGEN TEST FACILITY

MICHAEL J. MORGAN, JERRY E. BEAM (USAF, Wright Lab., Wright-Patterson AFB, OH), MANINDER S. SEHMBEY, MARTIN R. PAIS, LOUIS C. CHOW, and O. J. HAHN (Kentucky Univ., Louisville) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 2 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 2.417-2.423. Research sponsored by USAF refs

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The design and construction of a hydrogen test facility planned as part of a study of thermal and fluid instabilities during blowdown of supercritical fluids at cryogenic temperature are described. The facility will be capable of providing supercritical hydrogen at 30 bars and 35 K at a maximum flow rate of 0.1 kg/s for 90 s.

C.D.

A93-26920

AIRPORT TECHNOLOGY INTERNATIONAL 1993

GEORGE PAPAGIORCOPULO, ED. (Malta International Airport Co., Ltd., Luqa) London Sterling Publications International, Ltd. 1992 155 p.

Copyright

The present survey of developments in airport technologies and their management discusses airport extensions and upgrades, airport developments in China, polluter penalization, airport effects on environments, European ground-handling methods, ATC in Europe, EC duty-free sales at airports, and the privatization of airport security. Also discussed are airport advertising, new alternatives in air-cargo handling, ATC training, taxi-guidance systems, and the reduction of fuel consumption and emissions on the ground. (No individual items are abstracted in this volume)

O.C.

A93-27043

SENSORS AND SENSOR SYSTEMS FOR GUIDANCE AND NAVIGATION; PROCEEDINGS OF THE MEETING, ORLANDO, FL, APR. 2, 3, 1991

JACK WADE, ED. (Ball Aerospace Systems Group, Boulder, CO) and AVI TUCHMAN, ED. (Textron Defense Systems, Everett, MA) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1478) 1991 256 p. (SPIE-1478; ISBN 0-8194-0587-6) Copyright

The present conference discusses wide field-of-view star-tracker cameras, discrete frequency vs radius reticle trackers, a sensor system for comet approach and landing, a static horizon sensor for a remote-sensing satellite, an improved ring laser gyro navigator, FM reticle trackers in the pupil plane, and the 2D encoding of images via discrete reticles. Also discussed are reduced-cost coil windings for interferometric fiber-optic gyro sensors, the ASTRO 1M space attitude-determination system, passive range-sensor refinement via texture and segmentation, a coherent launch-site atmospheric wind sounder, and a radar-optronic tracking experiment for short and medium range aerial combat. (For individual items see A93-27044 to A93-27046) O.C.

A93-27046* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

AUTONOMOUS GUIDANCE, NAVIGATION AND CONTROL BRIDGING PROGRAM PLAN

G. G. MCSWAIN, S. T. FERNANDES, and K. B. DOANE (NASA, Johnson Space Center; McDonnell Douglas Space Systems Co., Houston, TX) In Sensors and sensor systems for guidance and navigation; Proceedings of the Meeting, Orlando, FL, Apr. 2, 3, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 228-238. refs

(Contract NAS9-17885)

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A four-center NASA team has undertaken to develop and demonstrate mature technologies applicable to autonomous guidance, navigation, and control (GNC) systems for application to the National Space Transportation System in full cognizance of its operational, safety, and performance requirements, as well as its cost constraints. Attention is to be given to GNC launch/landing weather assessment, ascent guidance, ascent load relief, and system failure during ascent. Preliminary results indicate that a ground-computed atmospheric steering profile can achieve near-optimum performance as well as high cost effectiveness.

O.C.

A93-28437

FLYING QUALITIES OF THE HERMES SPACEPLANE AND THE SHAPE DEFINITION PROCESS

CHEMISTRY AND MATERIALS

E. RAILLON (ESA; CNES, Toulouse, France), P. PARNIS (Dassault Aviation, Blagnac, France), and N. DEVAUX (Dassault Aviation, Saint-Cloud, France) *ESA Journal* (ISSN 0379-2285) vol. 16, no. 4 1992 p. 419-434.

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This paper discusses the most recent Hermes spaceplane (Shape 1.0) design definition and evaluation cycle, focussing on the craft's flying qualities, performance parameters and other main design considerations. The critical mission phases associated with Hermes are described, and trajectory-control principles and flight-parameter envelopes are defined. The principal reasons why Hermes is dissimilar to the US Space Shuttle Orbiter and the CIS's Buran spaceplane are also explained. Author

A93-28488**SONIC BOOM SPECTRA OF SPACE SHUTTLE COLUMBIA LANDING 10 DECEMBER 1990**

ROBERT W. YOUNG *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 345-348.

Copyright

The sonic boom waveform at the ground during the Columbia landing on December 10, 1990 was an almost ideal N-wave, duration near 400 ms. The flat sound exposure spectrum level to 100 Hz (overlay for T = 100 ms, peak 1 Pa) is shown, and the flat sound exposure spectrum level to 1000 Hz is illustrated in graphic form. C.A.B.

A93-29607**PROPAGATION RESULTS OF AERONAUTICAL SATELLITE COMMUNICATION EXPERIMENTS USING INMARSAT SATELLITE**

TOSHIYUKI IDE, RYUTARO SUZUKI, and KIMIO KONDO (Communications Research Lab., Koganei, Japan) *IEEE Transactions on Aerospace and Electronic Systems* (ISSN 0018-9251) vol. 28, no. 4 Oct. 1992 p. 1155-1157. refs

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Aeronautical satellite communication experiments were conducted using a top-mounted high-gain antenna of the phased-array type. Slow fading of 3 to 4 dB in the L-band channel was observed when the wing direction coincides with the satellite direction, in contrast with the small fading observed in the cases where the aircraft wing is out of the beam pointing to the satellite. I.E.

N93-20428# National Space Development Agency, Ibaraki (Japan). Guidance and Control Lab.

RESEARCH ON COMBINED HOPE NAVIGATION TECHNOLOGY [HOPE FUKUGOU KOUHOU GIJUTSU NO KENKYUU]

HIDETO SUZUKI, HITOSHI MINENO, SHIGEHIRO MORI, ISAO KAWANO, SHUICHI MATSUMOTO, and SHINGO HIRATA *In* its Research and Development Activities of the Tsukuba Space Center p 85-88 Aug. 1992 *In* JAPANESE
Avail: CASI HC A01/MF A03

An overview of the research on navigation sensors of HOPE (H-2 Orbiting Plane) required for landing and on-orbit phases is presented. Microwave Landing System (MLS) which is a system to measure required azimuth and elevation from the runway for landing and an element for combined navigation with inertial sensor and RF (Radio Frequency) altimeter, were trial produced and tested. Trial production and test of the research model Global Positioning System (GPS) which receives RF wave from 24 (scheduled) satellites deployed in space were completed. Preparatory operation tests were conducted with the functional model of the fixed star sensor to measure spacecraft attitude in reference to space.

Author (NASDA)

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A93-24464**LIFE ASSESSMENT OF GAS TURBINE BUCKET COATING BASED ON DEGRADATION ANALYSIS**

YOMEI YOSHIOKA, DAIZO SAITO, ITARU MURAKAMI, KAZUNORI FUJIYAMA, and NAGATOSHI OKABE (Toshiba Corp., Yokohama, Japan) *Japan Society of Materials Science, Journal* (ISSN 0514-5163) vol. 41, no. 471 Dec. 1992 p. 1724-1728. *In* Japanese. refs

Copyright

The role of coating in the first-stage bucket life of gas turbines is clarified. The degradation mechanism of platinum-modified aluminide diffusion coating and vacuum plasma-sprayed Co-Cr-Al-Y coating is described based on results of investigations on macro- and microstructural degradation behaviors of buckets exposed to service for 11,000 and 25,000 hrs. The life exhaustion concept of a first-stage bucket and coating is addressed. C.D.

A93-24509**MODEL MULTILAYER STRUCTURED COMPOSITES**

M. A. HOISINGTON and J. C. SEFERIS (Washington Univ., Seattle) *SAMPE Quarterly* (ISSN 0036-0821) vol. 24, no. 2 Jan. 1993 p. 10-20. Research supported by Boeing Commercial Airplane Group refs

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Increasing the toughness of thermosetting matrix composites for use in primary structures of commercial aircraft has been the target of over a decade of intense research efforts. Recently, commercial toughened thermosetting systems have been successful in achieving the desired requirements for primary structures with the use of matrix layering concepts. Layering is accomplished by the incorporation of a thin layer of a toughened resin matrix between plies that results in the creation of a multilayer composite structure. This work concentrates on simulating these commercial systems with the development of a model multilayer composite system that contains a heterogeneous resin layer between plies. Processing of the model system was accomplished with a two step impregnation process followed by an autoclave curing process. The final composite structure contained a resin rich layer between plies that incorporated a second phase of dispersed thermoplastic modifier particles. Each step in the processing of the model system was analyzed and quantitatively described in detail in order to develop a fundamental understanding of these new toughening composite concepts. Author

A93-24882#**RESULTS OF HIGH TEMPERATURE JP-7 CRACKING ASSESSMENT**

T. EDWARDS and S. D. ANDERSON (USAF, Wright Lab., Wright-Patterson AFB, OH) Jan. 1993 11 p. *AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993* refs

(AIAA PAPER 93-0806)

Thermal cracking of JP-7 flowing through a heated tube was investigated as a possible high temperature heat sink for aircraft. It was found that the endothermicity of the reactions was on the order of 300 BTU/lb, much less than the theoretical maximum of 1500 BTU/lb. The decrease from the theoretical value was due to significant formation of saturated species and aromatics.

Author

A93-24883#**USAF SUPERCRITICAL HYDROCARBON FUELS INTERESTS**

TIM EDWARDS (USAF, Wright Lab., Wright-Patterson AFB, OH)

Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0807)

Fuels utilized in high-speed aircraft will have to absorb large amounts of excess heat for aircraft thermal management requirements, which will result in the fuels being heated to supercritical conditions. Important properties of these supercritical fuels are presented. Consideration is given to thermal stability, heat transfer, and supercritical fuel injection. R.E.P.

A93-24884#

MEASUREMENT OF DIFFUSION IN SUPERCRITICAL FLUID SYSTEMS - A REVIEW

THOMAS J. BRUNO (NIST, Boulder, CO) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0809)

In this paper, the experimental procedures that are applicable to the measurement of diffusion in supercritical fluid solutions will be reviewed. This topic is of great importance to the proper design of advanced aircraft and the turbine fuels these aircraft will use. The main reason for this is that the fuels on these high performance aircraft may sometimes operate under supercritical fluid conditions when they are used as a heat sink, for the cooling of friction-heated surfaces. These conditions may produce unfavorable chemical reactions in the fuel. The decomposition products so produced will therefore be a major cause of heat exchanger fouling, and this must be addressed in the early stages of fuel and component design. Since transport properties are needed for these designs, we will consider measurements of one of the most critical: the binary interaction diffusion coefficient. After a brief introduction to the concept of diffusion, we will discuss in detail the use of chromatographic methods, and then briefly treat light scattering, nuclear magnetic resonance spectra, and physical methods.

Author

A93-25252

EFFECTS OF THERMAL HISTORY AND JET FUEL ABSORPTION ON THE PROPERTIES OF APC-2

JOHN D. RUSSELL and DAVID B. CURLISS (USAF, Wright Lab., Wright-Patterson AFB, OH) Journal of Thermoplastic Composite Materials (ISSN 0892-7057) vol. 5, no. 3 July 1992 p. 238-255. refs Copyright

The response of APC-2 (AS4/PEEK) processed with different thermal histories simulating different fabrication techniques was investigated. Three thermal histories were evaluated: (1) slow cooled (SC) from the melt state at 2 C/min; (2) rapidly quenched (Q) from the melt state by cold press transfer; and (3) quenched and annealed (Q/A) at 160 C. The SC APC-2 was found to have a fully developed semicrystalline matrix and the highest strength and modulus for flexural and shear tests, while the Q APC-2 was found to have an essentially amorphous matrix and the greatest fracture toughness. In uniaxial creep tests of (+/- 45 deg)2s coupons both exposed and unexposed to JP-4, the unexposed Q specimens had the highest creep rates at room temperature and 100 C. The exposed SC specimens had the highest creep rates at 100 C because of the plasticization effect of the absorbed JP-4.

Author

A93-25532#

EXPERIMENTAL AND NUMERICAL INVESTIGATIONS OF THE VORTEX-FLAME INTERACTIONS IN A DRIVEN JET DIFFUSION FLAME

K. Y. HSU, L. D. CHEN (Iowa Univ., Iowa City), V. R. KATTA, L. P. GOSS (Systems Research Labs., Inc., Dayton, OH), and W. M. ROQUEMORE (USAF, Wright Lab., Wright-Patterson AFB, OH) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract F49620-92-J-0462) (AIAA PAPER 93-0455)

Phase-locked Reactive-Mie-Scattering and Planar-Laser-Induced-Fluorescence (PLIF) are used to visualize the

vortex structure and OH zone, respectively. The evolution of the vortex-flame interaction is presented. The forcing vortex, convected in the radial direction, causes the flame to bulge outward. When the flame surface is further stretched, a local quenching around the flame is observed. Thin-Filament-Pyrometry is used to record the temperature variation during the interaction process. A sudden decrease in flame temperature indicates the occurrence of local quenching. The thinning and disappearance of the OH zone during the quenching process is also illustrated by OH-PLIF imaging. A time-dependent numerical simulation reproduces the vortex structure and the dynamic vortex-flame interaction observed in the experiment. Although the fast chemistry model fail to predict the quenching, the calculation demonstrates the importance of transport phenomena during the vortex-flame interaction. Author

A93-25686

INCOLOY 908, A LOW COEFFICIENT OF EXPANSION ALLOY FOR HIGH-STRENGTH CRYOGENIC APPLICATIONS. I - PHYSICAL METALLURGY

M. M. MORRA, R. G. BALLINGER, and I. S. HWANG (MIT, Cambridge, MA) Metallurgical Transactions A - Physical Metallurgy and Materials Science (ISSN 0360-2133) vol. 23A, no. 12 Dec. 1992 p. 3177-3192. refs

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The evolution of the microstructure of INCOLOY 908 is studied as a function of time at temperature over the range of 650 to 900 C for times between 50 and 200 hr. XRD, TEM, and analytical scanning and scanning TEM techniques are employed to analyze precipitated phases. INCOLOY 908 is found to be stable against overaging for times to 100 hr at temperatures up to 750 C.

C.A.B.

A93-25911

PARAMETER EFFECTS ON TURBULENT SWIRLING FLAMES IN COMBUSTORS

MINGCHUN DONG and DAVID G. LILLEY (Oklahoma State Univ., Stillwater) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 1 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 1.383-1.388. refs

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A computer code has been developed to simulate the turbulent combustion flowfield of an axisymmetric swirling flow in a typical combustor. Premixed fuel (methane) and air enter the combustor through the main primary inlet. Additionally, a top wall secondary annular inlet is permitted through which cooling dilution air flows. Once the geometric sizes of the domain and inlets are specified parameters of interest include the primary fuel-air ratio and aerodynamic specification of all the inflows. This includes the secondary to primary velocity ratio, primary swirl and contraction angles, and secondary swirl and upstream angles. Combustion flowfield predictions are given to illustrate the effects of these parameters on the flowfield (velocities, species concentrations, temperature and turbulence levels), and dramatic effects are illustrated via radial profiles and streamline patterns. Author

A93-27366

STUDY OF THE METHOD FOR DETERMINING RESIDUAL STRESS INDUCED BY MACHINING IN AIRPLANE CANOPIES MADE OF PMMA

ZI-MING WANG (Beijing Inst. of Aeronautical Materials, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 4 Nov. 1992 p. 243-248. Translation. Previously cited in issue 22, p. 3921, Accession no. A92-53096 refs

Copyright

A93-27658

EFFECT OF COMBUSTION ON THE INTERACTION OF AN UNDEREXPANDED WALL HYDROGEN JET WITH SUPERSONIC FLOW IN A PLANE DUCT [VLIANIE GORENIIA NA VZAIMODEISTVIE PRISTENNOI NEDORASSHIRENNOI STRUI VODORODA SO SVERKHZVUKOVYM POTOKOM V PLOSKOM KANALE]

O. M. KOLESNIKOV Fizika Goreniia i Vzryva (ISSN 0430-6228) vol. 28, no. 6 Nov.-Dec. 1992 p. 11-17. In Russian. refs Copyright

Results of analytical studies of the combustion of an underexpanded wall hydrogen jet, injected into high-temperature supersonic flow along the wall of a plane duct, are reported. Parabolized Navier-Stokes equations are solved by a marching algorithm using global iterations in terms of pressure. Particular attention is given to the effect of combustion on the interaction of the turbulent wall jet with the generated compression shocks. It is shown that combustion leads to a significant increase in the inhomogeneity of the static pressure field, formation of subsonic waves within the supersonic flow, and, in some cases, to the separation in the region of interaction between the strongest compression shock and the boundary layer. V.L.

A93-27726

COMBUSTION AND REACTION KINETICS; PROCEEDINGS OF THE 22ND INTERNATIONAL ANNUAL CONFERENCE OF ICT, KARLSRUHE, GERMANY, JULY 2-5, 1991

Pfintzal, Germany Fraunhofer-Institut fuer Chemische Technologie (ISSN 0722-4087) 1991 1349 p. In English, German, and French.

The main topics discussed include fluid dynamics and flame reactors; turbulent combustion processes; solid-phase reactions and pyrolysis behavior; and combustion in high-velocity flow fields. Deflagration/detonation and safety aspects are also considered along with environmentally safe combustion and disposal. (For individual items see A93-27727 to A93-27769) L.M.

A93-27732

IGNITION AND SPREAD OF COMBUSTION WITHIN A SUPERSONIC BOUNDARY LAYER

LUIS F. F. DA SILVA, BRUNO DESHAIES, and MICHEL CHAMPION (Ecole Nationale Supérieure de Mécanique et d'Aérotechnique, Poitiers, France) In Combustion and reaction kinetics; Proceedings of the 22nd International Annual Conference of ICT, Karlsruhe, Germany, July 2-5, 1991 Pfintzal, Germany Fraunhofer-Institut fuer Chemische Technologie 1991 p. 21-1 to 21-13. Research supported by SEP refs

Development of Scramjet engines requires a better knowledge of the coupling between supersonic flow and combustion chemical kinetics. From this point of view, we consider a stationary uniform, laminar supersonic flow of an hydrogen-air mixture on a flat plate. Conditions of the flow at the outer edge of the boundary layer are chosen such that the chemical time is 'infinitely' large when compared to the transit time over the computational domain. Ignition is triggered inside the boundary layer by viscous dissipation effects and/or wall temperature. This problem is solved numerically by a finite difference technique coupled with a chemical kinetics special solver and using classical boundary layer assumptions. Author

A93-27759

STUDIES OF FUEL-RICH MAGNESIUM PROPELLANTS IN A SMALL SOLID FUEL RAMJET COMBUSTOR

PETER WIMMERSTROM and ROGER LUNDGREN (National Defence Research Establishment, Tumba, Sweden) In Combustion and reaction kinetics; Proceedings of the 22nd International Annual Conference of ICT, Karlsruhe, Germany, July 2-5, 1991 Pfintzal, Germany Fraunhofer-Institut fuer Chemische Technologie 1991 p. 96-1 to 96-7. refs

The paper discusses combustion tests with fuel-rich magnesium propellants which contained ammonium perchlorate, with and without iron oxide as a burning catalyst. Hydroxyl-terminated polybutadiene was used as a binder for the propellants and as a reference for the theoretical calculations. The tests were performed in a small solid fuel ramjet combustor which was supplied with compressed and preheated air from a tank storage. In this study, new testing equipment was used for the first time. The results showed that adding 2 percent iron oxide to the propellant doubled the regression rate, and that the air/propellant ratio was directly proportional to the length of the propellant grain. Author

A93-27766

IGNITION PROCESS OF FUEL DROPLET ARRAYS IN A SUPERSONIC FLOWFIELD

JIR-MING CHAR, JONG-SU MU (National Cheng Kung Univ., Tainan, Taiwan), and SHYH-DING JANG (Chung Shan Inst. of Science and Technology, Longtan, Taiwan) In Combustion and reaction kinetics; Proceedings of the 22nd International Annual Conference of ICT, Karlsruhe, Germany, July 2-5, 1991 Pfintzal, Germany Fraunhofer-Institut fuer Chemische Technologie 1991 p. 109-1 to 109-12. Research supported by Chung Shan Inst. of Science and Technology refs (Contract NSC-80-0210-D006-04)

The study of fuel droplet ignition and combustion in a supersonic flowfield plays an important role in recent combustion technology. The shock tube is the basic facility in the present experiment. By using the characteristics of high temperature and high velocity behind a shock wave, droplet ignition and combustion in a supersonic environment is performed. In the test section, there are three highly dynamic pressure transducers, one photodetector, two quartz windows, and a droplet generator. A high speed movie camera is also used to observe the deformation shattering, and ignition process of fuel droplets in the supersonic flow field.

Author

A93-28393

HIGH-TEMPERATURE MATERIALS WARM UP FOR DEBUT

ALAN S. BROWN Aerospace America (ISSN 0740-722X) vol. 31, no. 3 March 1993 p. 18-21, 27.

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A current development status evaluation and performance improvement forecast is presented for the lightweight, high specific strength, high temperature materials that have been explored as bases for future gas turbine engines in such proof-of-technology programs as the USAF Integrated High Performance Turbine Engine Initiative and NASA's High Temperature Materials Technology Program. Attention is given to superplastically formable Ti, TiAl intermetallics, metal-matrix composites, and ultrahigh tensile strength ceramic reinforcing fibers. These technologies are noted to be critical to the High Speed Civil Transport, or second-generation SST. O.C.

A93-29563

ISOTHERMAL OXIDATION BEHAVIOR OF ALPHA-2 TITANIUM ALUMINIDE ALLOYS

J. C. SCHAEFFER (GE Aircraft Engines, Cincinnati, OH) Scripta Metallurgica et Materialia (ISSN 0956-716X) vol. 28, no. 7 April 1, 1993 p. 791-796. refs

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The isothermal oxidation behavior of Ti-25Al-10Nb-3V-1Mo and Ti-24.5Al-12.5Nb-1.5Mo in the 593-705 C temperature range is characterized, and the observed differences are discussed. The isothermal oxidation behavior in air of Ti-24.5Al-12.5Nb-1.5Mo was found to be superior to Ti-25Al-10Nb-3V-1Mo and Ti-6242 in the temperature range of 593-705 C. The 12.5-1.5 alloy was better because an external alumina scale formed which grew more slowly than the TiO₂-based scales observed in the 10-3-1 and Ti-6242. The alumina scale formed on the 12.5-1.5 alloy because interstitials like O, N, and C lower the thermodynamic activity of Ti to levels where Al₂O₃ formation is favored. In the absence of microstructural effects, the V in 10-3-1 prevented continuous external alumina from forming. P.D.

N93-20016 Department of the Navy, Washington, DC.

MASS LOADED COMPOSITE ROTOR FOR VIBRO-ACOUSTIC APPLICATION Patent

WILLIAM K. BLAKE, inventor (to Navy), ALEKSANDER B. MACANDER, inventor (to Navy), and JONATHAN GERSHFELD, inventor (to Navy) 8 Sep. 1992 8 p Filed 28 Aug. 1990 (AD-D015604; US-PATENT-APPL-SN-573769) Avail: CASI HC A02/MF A01

This patent discloses a rotor and a method for the production thereof which incorporates the inherently strong, highly damped, yet light weight characteristics of fiber reinforced plastic

composites, achieving with a minimal amount of added weight in the form of high density material a significant reduction in the vibratory response of the rotor due to hydrodynamic flow excitation, by selectively tailoring the mass distribution therein as by adding the high density material at selected locations of the rotor. GRA

N93-20041*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

IMPROVED CERAMIC SLIP CASTING TECHNIQUE Patent Application

GREGORY M. BUCK, inventor (to NASA) and PETER VASQUEZ, inventor (to NASA) 22 Sep. 1992 9 p
(NASA-CASE-LAR-14471-1; NAS 1.71:LAR-14471-1;
US-PATENT-APPL-SN-950580) Avail: CASI HC A02/MF A01

A primary concern in modern fluid dynamics research is the experimental verification of computational aerothermodynamic codes. This research requires high precision and detail in the test model employed. Ceramic materials are used for these models because of their low heat conductivity and their survivability at high temperatures. To fabricate such models, slip casting techniques were developed to provide net-form, precision casting capability for high-purity ceramic materials in aqueous solutions. In previous slip casting techniques, block, or flask molds made of plaster-of-paris were used to draw liquid from the slip material. Upon setting, parts were removed from the flask mold and cured in a kiln at high temperatures. Casting detail was usually limited with this technique -- detailed parts were frequently damaged upon separation from the flask mold, as the molded parts are extremely delicate in the uncured state, and the flask mold is inflexible. Ceramic surfaces were also marred by 'parting lines' caused by mold separation. This adversely affected the aerodynamic surface quality of the model as well. (Parting lines are invariably necessary on or near the leading edges of wings, nosetips, and fins for mold separation. These areas are also critical for flow boundary layer control.) Parting agents used in the casting process also affected surface quality. These agents eventually soaked into the mold, the model, or flaked off when releasing the case model. Different materials were tried, such as oils, paraffin, and even an algae. The algae released best, but some of it remained on the model and imparted an uneven texture and discoloration on the model surface when cured. According to the present invention, a wax pattern for a shell mold is provided, and an aqueous mixture of a calcium sulfate-bonded investment material is applied as a coating to the wax pattern. The coated wax pattern is then dried, followed by curing to vaporize the wax pattern and leave a shell mold of the calcium sulfate-bonded investment material. The shell mold is cooled to room temperature, and a ceramic slip is poured therein. After a ceramic shell of desired thickness has set up in the shell mold, excess ceramic slip is poured out. While still wet, the shell mold is peeled from the ceramic shell to expose any delicate or detailed parts, after which the ceramic shell is cured to provide a complete, detailed, precision ceramic article without parting lines. NASA

N93-20237*# Sverdrup Technology, Inc., Brook Park, OH. Research Center Group.

COMPUTATION OF H₂/AIR REACTING FLOWFIELDS IN DRAG-REDUCTION EXTERNAL COMBUSTION

H. T. LAI Cleveland, OH Jul. 1992 18 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by the AIAA, SAE, ASME, and ASEE Previously announced in IAA as A92-54115
(NASA-CR-191071; E-7624; NAS 1.26:191071; AIAA PAPER 92-3672) Avail: CASI HC A03/MF A01

Numerical simulation and analysis of the solution are presented for a laminar reacting flowfield of air and hydrogen in the case of external combustion employed to reduce base drag in hypersonic vehicles operating at transonic speeds. The flowfield consists of a transonic air stream at a Mach number of 1.26 and a sonic transverse hydrogen injection along a row of 26 orifices. Self-sustained combustion is computed over an expansion ramp downstream of the injection and a flameholder, using the recently developed RPLUS code. Measured data is available only for surface

pressure distributions and is used for validation of the code in practical 3D reacting flowfields. Pressure comparison shows generally good agreements, and the main effects of combustion are also qualitatively consistent with experiment.

Author (revised)

N93-20247# Department of the Navy, Washington, DC. INTERFEROMETRIC JFTOT TUBE DEPOSIT MEASURING DEVICE Patent Application

ROBERT E. MORRIS, inventor (to Navy) and ROBERT WAGNER, inventor (to Navy) 30 Jun. 1992 27 p
(AD-D015599; US-PATENT-APPL-SN-906903;
NAVY-CASE-73567) Avail: CASI HC A03/MF A01

Jet fuels are tested for thermal stability by passing the fuel over a heated metal tube and measuring the amount of residue deposited as a film on the tube as a result of chemical changes to the fuel. The thickness distribution and volume of a deposited film on a tube are calculated by scanning the length of the tube with an optical probe, shining light onto the tube, measuring the intensity of reflected light of a preselected wavelength from the tube, and correlating the reflected light intensity with positions on the tube. The tube is then partially rotated, and the process is repeated until the entire surface of the tube is scanned. The volumes of each longitudinal slice of the tube are summed to give the total deposit volume on the tube. GRA

N93-20275# Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.

FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS

Technical Progress Report, 16 Nov. - 15 Dec. 1992

CHARLES ANNIS 17 Dec. 1992 8 p

(Contract N00014-91-C-0124)

(AD-A259191; PW/FR-21998-14) Avail: CASI HC A02/MF A01

This program investigates the seemingly unusual behavior of single crystal airfoil materials. The fatigue initiation processes in single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional isotropic materials. To understand these differences is the major goal of this project. GRA

N93-20624# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

SMART MATERIALS

RAYMOND M. MEASURES /in Manitoba Univ., Proceedings of the Thirteenth Canadian Congress of Applied Mechanics p 94-96 May 1991

Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

Smart material technology will require the development of structurally integrated fiber optic reticulate sensor (SIFORS) technology. Improved safety would follow from real-time continuous surveillance of structural integrity of each critical component as well as from better quality control during fabrication. Also since structural weaknesses would be indicated before they become critical this could allow longer periods between major and costly inspections and a shorter downtime since the built-in sensors would have already indicated sites of weakness and their rate of deterioration prior to inspection. An overview of the new field of smart materials is presented and research towards the development of the required structurally integrated fiber optic sensors is reviewed. This includes the development of the first full-scale fiber optic damage assessment test system in the form of a composite aircraft leading edge and the fabrication, characterization and evaluation of the first fiber optic strain rosette. Author (CISTI)

N93-20845# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Helicopter Div.

DEVELOPMENT OF CURE CYCLES: FROM LABORATORY ANALYSIS AND TESTING TO PRODUCTION OF LARGE SCALE COMPOSITES

PETER AUER, RAINER NEUMAIER, and KLAUS SCHMIDTKE 1992 16 p Presented at 13th International Conference and

Exhibition on Advanced Materials and Structures, from Research to Application, Hamburg, Germany, 11-13 May 1992
(MBB-Z-0442-92-PUB; ETN-92-92757) Avail: CASI HC A03/MF A01

The development of the different cure cycles is described concentrating upon the transformation from laboratory data to production scale. The latter is summarized in tables which compare laboratory conditions to differences and problems arising from the dimensions of large complex parts. The differences between laboratory and production scale and the resulting difficulties are discussed for three structural parts: a helicopter rotor system, a railway bogie, and aircraft fuselage. The manufacturing routes of the components for the helicopter rotor systems and the railway bogie is the same. They are based on thermal analysis investigations, (directional scanning calorimetry), and these are described. For the production of large complex parts for aircraft, the cure cycle has to be modified according to material related difficulties, problems associated with the curing reaction, and manufacturing facilities. Each of these are considered and discussed. ESA

N93-21462# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Unternehmensbereich Flugzeuge.

ALLOWABLE COMPRESSION STRENGTH FOR CFRP-COMPONENTS OF FIGHTER AIRCRAFT DETERMINED BY CAI-TEST

J. BAUER, GEORG GUENTHER, and R. NEUMEIER 14 May 1992 10 p Presented at 74th AGARD Structures and Materials Panel Meeting, Patras, Greece, 24-29 May 1992
(MBB-FE-221-S-PUB-0483; ETN-93-93431) Copyright Avail: CASI HC A02/MF A01

Since reliable strength prediction methods are not yet available, a comprehensive test program was conducted utilizing a rather sophisticated test set up. This test set up was developed for a deeper examination of the influences from impact damages on the residual compression strength. The test procedure for Compression After Impact (CAI) is the so called 'Boeing test'. The test results data base formed the basis for the derivation of 'design allowables.' The test set up, the discovered mechanisms, and the derived 'design allowables' are presented. ESA

N93-21513# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. for Structural Mechanics.

GARTEUR DAMAGE MECHANICS FOR COMPOSITE MATERIALS: ANALYTICAL/EXPERIMENTAL RESEARCH ON DELAMINATIONS

M. GAEDKE, D. J. ALLMAN (Royal Aircraft Establishment, Farnborough, England.), C. CZEKAJSKI (Aerospatiale, Toulouse, France.), H. EGGERS, D. GILETTA (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.), R. GIRARD (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.), R. HILLGERT (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich, Germany.), J. LAMERIS (National Aerospace Lab., Amsterdam, Netherlands.), R. F. MOSLEY (Aerospatiale, Toulouse, France.), and R. T. POTTER (Aerospatiale, Toulouse, France.) /n AGARD, *Debonding/Delamination of Composites* 11 p Dec. 1992
Copyright Avail: CASI HC A03/MF A03

Currently used carbon fiber reinforced plastics (CFRP) - mainly with epoxy matrices - show a sensitive reaction to impact damage which stimulated the establishment of a cooperation program within GARTEUR (Group of Responsibles for Structures and Materials). Studies in this field had shown that delamination is a critical damage in this area for airframe structures with principal points of concern of tendency of buckling of delaminated areas and potential growth of delaminations. Author (revised)

N93-21518# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

MODELISATION AND COMPUTATION OF COMPOSITE MATERIALS

GEORGES DUVAUT /n AGARD, *Debonding/Delamination of*

Composites 5 p Dec. 1992 Prepared in cooperation with Paris VI Univ., France

Copyright Avail: CASI HC A01/MF A03

Composite materials are more and more widely used in aeronautical and spacial engineering and industry. Their main advantage is the gain in weight but it is not the only one: noncorrosion and their ability to assume complex functions without bearings are also very valuable in some cases. The drawback is the difficulty to predict their behavior and write valuable constitutive relations to perform structure computations. This is due to the microscopic heterogeneities and the various phases and interfaces whose behavior is not well-known. In this paper, we propose a homogenization method which allows, when the microscopic structure can be assumed periodic at some intermediate scale, to build a constitutive relation from the assumed knowledge of the behavior of the various phases and interfaces. Author

N93-21531# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).

ALLOWABLE COMPRESSION STRENGTH FOR CFRP-COMPONENTS OF FIGHTER AIRCRAFT DETERMINED BY CAI-TEST

J. BAUER, G. GUENTHER, and R. NEUMEIER /n AGARD, *Debonding/Delamination of Composites* 6 p Dec. 1992
Copyright Avail: CASI HC A02/MF A03

A test set-up was developed for CAI tests allowing coupon sizes from 300 x 100 up to 300 x 250 mm and thicknesses from 4 to 8 mm. The test set-up was approved to measure the residual compression strength after impact in accordance with other test methods e.g. the 'Boeing Test' and 4-point bending boxes. The test set-up is applicable for the investigation of all relevant test parameters and provides in addition to current test procedures the possibility to vary the geometric dimensions, width and thickness, in a wide comfortable range. This performance emphasizes its application for data collection and subsequent Design Allowables derivation. The experience with the Damage Tolerance aspects during the development of a fighter aircraft demonstrates that it is possible to introduce and consider impact requirements in the structural design phase. Author (revised)

N93-21533# Dornier Luftfahrt G.m.b.H., Friedrichshafen (Germany).

NUMERICAL DETERMINATION OF THE RESIDUAL STRENGTH OF BATTLE DAMAGED COMPOSITE PLATES

T. SCHNEIDER, J. MOEWS, and M. ROTHER /n AGARD, *Debonding/Delamination of Composites* 16 p Dec. 1992
Sponsored by Ministry of Defence Original contains color illustrations
Copyright Avail: CASI HC A03/MF A03

High energy impact damage by projectiles is a permanent threat to all aircraft or helicopters in combat situations. Besides the actual damage extent, caused by the incident, and its effect on airworthiness, the question of the residual strength of the damaged structure arises. Based on the experimental findings on the damage extent in shot-affected APC2/AS4 composite plates, a theoretical prediction of the residual compressive strength is given in terms of strength, stability, and fracture mechanics principles. These predictions are compared with test results from four specimens, which were cut out from the original plates. It will be shown, that the delaminations, caused by the high energy impact, triggered the final compressive failure of the specimens with the start of an unstable delamination growth and that this event can be correctly predicted by a numerical analysis, if local out-of-plane deformations are taken into account. Author (revised)

N93-21749*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

A K-OMEGA-MULTIVARIATE BETA PDF FOR SUPERSONIC COMBUSTION

G. A. ALEXOPOULOS, R. A. BAURLE, and H. A. HASSAN 1992 8 p
(Contract NAG1-244; NAGW-1331)

(NASA-CR-191930; NAS 1.26:191930) Avail: CASI HC A02/MF A01

In an attempt to study the interaction between combustion and turbulence in supersonic flows, an assumed PDF has been employed. This makes it possible to calculate the time average of the chemical source terms that appear in the species conservation equations. In order to determine the averages indicated in an equation, two transport equations, one for the temperature (enthalpy) variance and one for Q , are required. Model equations are formulated for such quantities. The turbulent time scale controls the evolution. An algebraic model similar to that used by Eklund et al was used in an attempt to predict the recent measurements of Cheng et al. Predictions were satisfactory before ignition but were less satisfactory after ignition. One of the reasons for this behavior is the inadequacy of the algebraic turbulence model employed. Because of this, the objective of this work is to develop a k - ω model to remedy the situation. Author

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A93-23804

MEASUREMENT OF SHED VORTICITY AND CIRCULATION FROM ROTATING AEROFOIL BY PARTICLE IMAGE VELOCIMETRY

I. GRANT, G. H. SMITH, A. LIU (Heriot-Watt Univ., Edinburgh, United Kingdom), D. INFELD (Rutherford Appleton Lab., Didcot, United Kingdom), and T. EICH (Univ. Essen-Gesamthochschule, Germany) *In Laser anemometry - Advances and applications 1991; Proceedings of the 4th International Conference, Cleveland, OH, Aug. 5-9, 1991. Vol. 1 New York American Society of Mechanical Engineers 1991 p. 357-363. refs*
Copyright

Results of wind tunnel experiments in which particle image velocimetry (PIV) was used to examine flow over a simple commercial wind turbine are reported. It is shown that both the region around the blade and that behind the blade can be investigated to provide quantitative measurements of relevant fluid characteristics using PIV. Measurements of the angle of attack, circulation, and vorticity are presented. V.L.

A93-23808

EXPERIMENTAL INVESTIGATION OF A 2D PARALLEL VORTEX/AIRFOIL INTERACTION

J. HAERTIG, C. JOHE, and P. GNEMMI (Saint-Louis, Franco-German Research Inst., France) *In Laser anemometry - Advances and applications 1991; Proceedings of the 4th International Conference, Cleveland, OH, Aug. 5-9, 1991. Vol. 2 New York American Society of Mechanical Engineers 1991 p. 413-424. refs*
(Contract DRET-88-214)
Copyright

A two-dimensional parallel vortex/airfoil interaction experiment has been performed in a water channel to obtain instantaneous velocity and vorticity fields. The vortex is created by a periodically pitching airfoil with a sawtooth-like movement. The test airfoil at zero angle of attack located downstream is fixed on a force balance to check the behavior of the lift coefficient. A 2D laser Doppler anemometer is used to measure the velocity at the node points of an O-shaped grid surrounding the test airfoil from the free stream to the boundary layer. The data sampling is synchronized with the vortex emission, so that the phase averaging processing gives instantaneous velocity and vorticity plots. A data base is

obtained which may be useful to compare experimental and theoretical results given by the perfect fluid potential flow theory or full Navier-Stokes codes. Author

A93-23809

TIME-DEPENDENT 3-COMPONENT LASER-DOPPLER-ANEMOMETER AND SIMULTANEOUS POSITION MEASUREMENTS IN THE FLOW OF AN AIRCRAFT ENGINE

U. SEELHORST, K. A. BUETEFISCH, H. GRAUER-CARSTENSEN, K. H. SAUERLAND, D. PALLEK (DLR, Inst. fuer Experimentelle Stromungsmechanik, Goettingen, Germany), and H. HOEISEL (DLR, Inst. fuer Entwurfsaerodynamik, Braunschweig, Germany) *In Laser anemometry - Advances and applications 1991; Proceedings of the 4th International Conference, Cleveland, OH, Aug. 5-9, 1991. Vol. 2 New York American Society of Mechanical Engineers 1991 p. 425-430. refs*
Copyright

Three-component laser-Doppler-anemometer measurements were carried out on a CFM 56-5/A1 fan turbine engine installed on an Airbus A 320 on the ground, while simultaneously taking the actual position of the measuring volume relative to the contour of the turbine engine. All measurements were taken at 80 percent of the maximum rotor speed, which is near cruise conditions. Fan and turbine flow as well as turbulence profiles, the swirl characteristics, and the inclination of the flow axis against the turbine axis have been obtained. Author

A93-24030

FULLY AUTOMATIC FEM DATA PRE-PROCESSING FOR AERONAUTICAL ELECTRICAL MACHINE

SHENGJIN LI, GANG LU, WEIGUO LIU, and ZHONGMING LI (Northwestern Polytechnical Univ., Xian, China) *Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 11, no. 1 Jan. 1993 p. 36-40. In Chinese. refs*

A method for FEM data preprocessing is presented that is fully automatic and also good in adaptability. The software package has been successfully applied to the design of three rare earth permanent magnetic electrical machines for important engineering projects. C.D.

A93-24035

IDENTIFICATION AND CONVERSION OF FOUNDATION PARAMETERS FOR AIRPORT PAVEMENT

SHIYING SHANG and SHANGWEN WANG (Northwestern Polytechnical Univ., Xian, China) *Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 11, no. 1 Jan. 1993 p. 91-95. In Chinese. refs*

The least squares method has been employed to fit measured and theoretical curves for the deflection of airport pavements, with the aim of identifying modulus of resilience E_0 and of reaction K . Using these moduli results in errors generally no larger than 10 percent. A more accurate method of converting E_0 into K and vice versa is proposed. The error is generally about 1 percent with maximum error not exceeding 2.7 percent. C.D.

A93-24084

A NAVIER-STOKES SIMULATION OF VORTEX SHEDDING FROM SQUARE CYLINDER IN UNCONFINED DOMAIN

S. K. MUKHERJEA and G. BANDYOPADHYAY (Indian Inst. of Technology, Kharagpur, India) *Aeronautical Society of India, Journal (ISSN 0001-9267) vol. 44, no. 3 Aug.-Sept. 1992 p. 209-213. refs*
Copyright

The paper develops a Navier-Stokes solver based on a pressure velocity formulation for calculating a laminar separated flow around a square cylinder in an unconfined domain. For calculating pressure, the method uses a combination of a pressure Poisson equation and a pressure correction term. Steady state vortex shedding is generally obtained after about 10,000 time steps. Results are presented for Reynolds numbers of 150 and 250. C.A.B.

A93-24122

DEVELOPMENT OF HIGHLY LOADED ROOT END ATTACHMENTS FOR COMPOSITE MATERIAL HIGH SPEED FLYING SURFACES

T. P. COOPER and R. A. S. WRIGHT (Council for Scientific and Industrial Research, Pretoria, South Africa) *In* Composite structures 6; Proceedings of the 6th International Conference, Paisley College of Technology, United Kingdom, Sept. 9-11, 1991 London and New York Elsevier Applied Science 1991 p. 507-518. refs

Copyright

In the design of cantilever composite flying surfaces, one of the most difficult problems to overcome is the interface with the aircraft fuselage. The authors describe some interface methodologies which significantly improve the load introduction at the interface between composite flying surface and a metal fuselage. Author

A93-24230*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A COUPLED MULTI-BLOCK SOLUTION PROCEDURE FOR SPRAY COMBUSTION IN COMPLEX GEOMETRIES

KUO-HUEY CHEN (Toledo Univ.; NASA, Lewis Research Center, Cleveland, OH) and JIAN-SHUN SHUEN (Sverdrup Technology, Inc.; NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 28 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0108) Copyright

Turbulent spray-combusting flow in complex geometries is presently treated by a coupled implicit procedure that employs finite-rate chemistry and real gas properties for combustion, as well as the stochastic separated model for spray and a multiblock treatment for complex geometries. Illustrative numerical tests conducted encompass a steady-state nonreacting backward-facing step flow, a premixed single-phase combustion flow, and spray combustion flow in a gas turbine combustor. O.C.

A93-24412

THREE-DIMENSIONAL FLOW OVER TWO SPHERES PLACED SIDE BY SIDE

INCHUL KIM, SAID ELGHOBASHI, and WILLIAM A. SIRIGNANO (California Univ., Irvine) *Journal of Fluid Mechanics* (ISSN 0022-1120) vol. 246 Jan. 1993 p. 465-488. Research supported by Univ. of California refs (Contract AF-AFOSR-90-0064) Copyright

Three-dimensional flow over two identical (solid or liquid) spheres which are held fixed relative to each other with the line connecting their centers normal to a uniform stream is investigated numerically at Reynolds numbers 50, 100, and 150. We consider the lift, moment, and drag coefficients on the spheres and investigate their dependence on the distance between the two spheres. The computations show that, for a given Reynolds number, the two spheres are repelled when the spacing is of the order of the diameter but are weakly attracted at intermediate separation distances. For small spacing, the vortical structure of the near wake is significantly different from that of the axisymmetric wake that establishes at large separations. The partially confined flow passing between the two spheres entrains the flows coming around their other sides. Our results agree with available experimental and numerical data. Author

A93-24484#

OPTICALLY SMART SURFACES FOR AERODYNAMIC MEASUREMENTS

JAMES D. TROLINGER and DAVID M. ROSENTHAL (MetroLaser, Irvine, CA) Jul. 1992 10 p. AIAA, Aerospace Ground Testing Conference, 17th, Nashville, TN, July 6-8, 1992 Research sponsored by USAF refs (AIAA PAPER 92-3895) Copyright

This paper describes a program to develop optically smart surfaces for aerodynamic measurements. Optically smart surfaces incorporate optical information in a thin holographic coating placed

on surface of a model or wind tunnel wall. The first smart surfaces were constructed with a layer of photoresist and an overlayer of aluminum to holographically store an optical instrument which is actuated by an impinging 'address' beam. Information on model strain, temperature, pressure, flow field velocity, skin friction, and turbulence can be impressed by the surface upon the address beam before it is returned to a receiver. The research has established theoretical feasibility for optically smart surfaces through a detailed analysis which was followed by the development of manufacturing techniques, and the construction, and successful experimental testing of a variety of smart surfaces. Efforts are underway to improve the sensor durability by developing techniques to etch the sensor into the model surface itself as opposed to using thin coatings. Author

A93-24486*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DOPPLER GLOBAL VELOCIMETRY - THE NEXT GENERATION?

JAMES F. MEYERS (NASA, Langley Research Center, Hampton, VA) Jul. 1992 12 p. AIAA, Aerospace Ground Testing Conference, 17th, Nashville, TN, July 6-8, 1992 refs (AIAA PAPER 92-3897) Copyright

A new measurement technique is being developed by NASA to measure off-surface flow fields. This method, Doppler global velocimetry, will allow quantification of complex three-dimensional flow fields at video camera rates. The entire flow field structure within a selected plane is measured simultaneously rather than by scanned, point-by-point measurements using conventional laser velocimetry. To assess the capability of this new technique, velocity measurements of the vortical flow field above a thin 75-degree delta wing were made in the NASA Langley Basic Aerodynamics Research Tunnel. The operation of the system is described along with the techniques developed to process the output images. The results are then compared with similar measurements obtained using a three component laser velocimeter. Author

A93-24748*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

CORRECTIONS TO FRINGE DISTORTION DUE TO FLOW DENSITY GRADIENTS IN OPTICAL INTERFEROMETRY

Y. C. CHO (NASA, Ames Research Center, Moffett Field, CA), L. W. CARR (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA), and M. S. CHANDRASEKHARA (U.S. Naval Postgraduate School, Monterey, CA) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0631) Copyright

An analytical method is formulated to account for distortions of optical interferograms used for studies of flow over airfoils experiencing dynamic stall. It is shown that such distortions are generated primarily due to optical path deflections in the test flow, caused by large density gradients. Such in-flow optical path deflections are neglected in conventional optical techniques for flow studies. The present method employs a ray analysis to determine these in-flow optical path deflections, and accurately predicts the interferogram distortions. Author

A93-24755*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

UNSTEADY PANEL METHOD FOR FLOWS WITH MULTIPLE BODIES MOVING ALONG VARIOUS PATHS

THOMAS F. RICHASON, JOSEPH KATZ (San Diego State Univ., CA), and DALE L. ASHBY (NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract NCC2-676) (AIAA PAPER 93-0640) Copyright

A potential flow based three-dimensional panel method was modified to treat time dependent conditions in which several submerged bodies can move within the fluid along different trajectories. This modification was accomplished by formulating the momentary solution in an inertial frame-of-reference, attached

to the undisturbed stationary fluid. Consequently, the numerical interpretation of the multiple-body, solid-surface boundary condition and the viscous wake rollup was considerably simplified. The unsteady capability of this code was validated by comparing computed and experimental results for a finite wing undergoing pitch oscillations. In order to demonstrate the multicomponent capability, computations were made for two wings following closely intersecting paths (e.g., to avoid mid air collisions) and for a flow field with relative rotation (e.g., helicopter-rotor/fuselage interaction). Results were compared to experimental data when such data was available. Author

A93-24757#

THE ANALYSIS OF UNSTEADY, THREE-DIMENSIONAL FLOW SEPARATION

R. W. HENK (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) and H. L. REED (Arizona State Univ., Tempe) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract N00014-84-K-0232; N00014-86-K-0066) (AIAA PAPER 93-0642) Copyright

The need for a simple method for analyzing and displaying the data from unsteady 3D flows is presently addressed via the Sandborn and Kline (1961) h-Gamma plane, which requires only that existing data be numerically integrated and plotted in 2D. Attention is given to the h-Gamma treatment of a developing and decaying 3D separation; the method is shown to furnish clues for discerning and modeling the stages of unsteady separation. O.C.

A93-24766*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL SIMULATIONS OF A HIGH MACH NUMBER JET FLOW

M. E. HAYDER, ELI TURKEL, and REDA R. MANKBADI (NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0653) Copyright

The present 2D simulations of plane and axisymmetric jets, which are relevant to current efforts to suppress the jet exhaust noise of prospective high-speed civil transports, were conducted by solving full Navier-Stokes equations by means of a high-order finite-difference scheme. The results obtained, which were able to generate the correct mode shape after an adjustment region of about 10 diameters, are in good agreement with linear-theory predictions of the growth of instability waves. O.C.

A93-24769#

IMPLICIT EULER CALCULATION OF SUPERSONIC VORTEX WAKE/ENGINE PLUME INTERACTION

PHILIP CALI and MARK DRELA (MIT, Cambridge, MA) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by NDSEG Fellowship Program refs (AIAA PAPER 93-0656) Copyright

This paper presents the computational modeling of supersonic vortex wake/engine plume interaction. The evolution of the wake and plume was modeled in the Trefftz plane using the two-dimensional, unsteady Euler equations. Test cases varying the initial spanwise location of the plume were conducted. In all cases, the plume was seen to break apart into small bundles which then orbited the vortex core. Although the inward pressure gradient of the rolled-up vortex drove the hot effluent toward the center, the inward motion of the buoyant plume fluid was limited due to the lack of a diffusive model. The amount of effluent drawn tightly to the core increased as the initial plume location was moved outward along the span. Author

A93-24828*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FIBER-OPTIC INTERFEROMETRIC SENSORS FOR MEASUREMENTS OF PRESSURE FLUCTUATIONS - EXPERIMENTAL EVALUATION

Y. C. CHO and P. T. SODERMAN (NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0738) Copyright

A fiber optic interferometric sensor that is being developed at NASA Ames Research Center for pressure fluctuation measurements in wind tunnels is considered. Preliminary evaluation indicates that the fiber optic interferometric sensor can be successfully used as an aeroacoustic sensor and is capable of providing a powerful instrument to solve complex acoustic measurement problems in wind tunnels. O.G.

A93-24833#

FINITE ELEMENT ANALYSIS OF THE SCRAMACCELERATOR WITH FINITE RATE CHEMISTRY

BARRY R. DYNE, JUAN C. HEINRICH (Arizona Univ., Tucson), and JOSEPH W. HUMPHREY (Advanced Projects Research, Inc., Moorpark, CA) Jan. 1993 9 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0745) Copyright

The Scramaccelerator concept is examined through numerical calculations in an attempt to establish its feasibility. A finite element method for inviscid flow calculations is coupled to a chemistry package, and simulations of steady-state detonation waves in a mixture of hydrogen and oxygen are performed for several values of Mach number, projectile-to-tube diameter ratio, mixture equivalence ratio, and fill pressure. The results are expressed in the form of thrust on the projectile. It is concluded that the forces developed are capable of inducing accelerations on the order of $10 \exp 5 \text{ m/s}^2$ on a 200-gram projectile, thereby corroborating the feasibility of this concept. Author

A93-24836#

ANTI-ICING FAILURE DETECTION INSTRUMENTATION USING REALTIME OPTICAL MEASUREMENT OF ANTI-ICING FLUID PROPERTIES

MICHAEL R. MULLER, PETER P. POLOMSKI, and JAMES C. LA DUE (Rutgers Univ., Piscataway, NJ) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by FAA refs (AIAA PAPER 93-0748) Copyright

Performance and limitations of three techniques for providing different information about the makeup of the thin anti-icing film used have been studied experimentally. These techniques include critical angle refractometry at the solid-liquid interface, analysis of the secondary reflection from the liquid-air interface, and determination of critical angles at internal positions within the deicing film. It is considered to be unlikely that any of these techniques can be totally sufficient for determining the onset of icing. The methods vary in complexity and what information they provide and all of them or certain methods may be useful in various applications. O.G.

A93-24851#

A FAST MULTIGRID METHOD FOR SOLVING INCOMPRESSIBLE HYDRODYNAMIC PROBLEMS WITH FREE SURFACES

J. FARMER, L. MARTINELLI, and A. JAMESON (Princeton Univ., NJ) Jan. 1993 15 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0767) Copyright

An efficient method to predict free surface wave phenomena is presented. The method is based on a combination of an artificial compressibility, the multigrid Euler scheme, and a free surface formulation. The method makes it possible to perform the straightforward extension to include viscous terms associated with Navier-Stokes equations and a turbulence model. The method is

applied to the free surface ship wave problem to show the method's versatility to problems other than incompressible low speed air flows. O.G.

A93-24852#

A MULTILEVEL COMPOSITE GRID METHOD FOR FLUID FLOW COMPUTATIONS

W. SHYY, J. WRIGHT, and J. LIU (Florida Univ., Gainesville) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0768) Copyright

A composite grid algorithm developed earlier for solving the incompressible Navier-Stokes equations has been further investigated with several improvements incorporated. The compatibility of general overlapping arrangements with the internal grid boundary treatment is analyzed. An improved zonal interface boundary treatment is presented which allows better accuracy for cases where a large grid resolution disparity exists across the interface. The issue of the overall solution efficiency of the present composite grid algorithm is also examined, including the effect of block overlap thickness and block partition pattern on solution convergence rate. A multigrid strategy is developed within the context of the composite grid procedure. Issues regarding the implementation of the multigrid approach within a composite grid framework, and the constraints imposed on the restriction procedure by the interface treatment are discussed. Author

A93-24860#

ON HIGH SPEED TURBULENCE MODELING OF SHOCK-WAVE BOUNDARY-LAYER INTERACTION

F. GRASSO and D. FALCONI (Roma I, Univ., Rome, Italy) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0778) Copyright

In the present paper some of the recent theoretical developments in compressible turbulence modeling are analyzed, and a model that accounts for compressibility as well as low Reynolds number effects is developed. The leading compressibility terms have been identified in the dilatation-dissipation, pressure-dilatation and the scalar product of the Favre velocity and mean pressure gradient. For the dilatation-dissipation a model similar to that of Zeman has been assumed; the pressure-dilatation is modeled according to Sarkar's model; and the 'Favre' contributions has been modeled with a gradient law. The model also accounts for compressibility effects on the von Karman's constant and on the turbulence length scale, which affects the heating rates. A study of hypersonic boundary layer flows and shock-wave boundary-layer interactions shows that the effects of compressibility depend on the flow complexity. Author

A93-24867#

INCOMPRESSIBLE FLOW COMPUTATION OF FORCES AND MOMENTS ON BODIES OF REVOLUTION AT INCIDENCE

CHAO-HO SUNG, MICHAEL J. GRIFFIN, JEFF F. TSAI, and THOMAS T. HUANG (U.S. Navy, Naval Surface Warfare Center, Bethesda, MD) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research sponsored by U.S. Navy refs (AIAA PAPER 93-0787)

A computer code developed for the solution of the incompressible Reynolds-Averaged Navier-Stokes (RANS) equations has been applied to compute the flows about bodies of revolution at angles of attack of 0, 4, 8, 12 and 16 degrees. The computed results have been compared with the experimental data measured on the SUBOFF and Albacore bodies. The emphasis of this work is investigation of the adequacy of the standard Baldwin-Lomax turbulence model and the modifications of the model required to improve accuracy. Author

A93-24868#

A CALCULATION METHOD FOR THE THREE-DIMENSIONAL BOUNDARY-LAYER EQUATIONS IN INTEGRAL FORM

BILAL MUGHAL and MARK DRELA (MIT, Cambridge, MA) Jan.

1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by Boeing Co refs

(AIAA PAPER 93-0786) Copyright

A new numerical method is developed to solve the three-dimensional boundary-layer equations, in integral form, on non-orthogonal grids. The finite-volume scheme employed eliminates the need to compute metric-gradient terms found in curvilinear-coordinate finite-difference methods. The integral method is based on two equations for momentum and one for kinetic energy with empirical equilibrium compressible turbulent-flow closure relations selectively extracted from the literature. Johnston's model is used for the crossflow. The non-linear discrete equations are solved simultaneously using the Newton-Raphson method along a row of cells and the solution is marched successively downstream. Along each row, cell residuals are distributed to nodes in a manner consistent with the local direction of characteristic lines. Results are computed for a well-known infinite swept wing case to evaluate empirical-closure accuracy, and for a finite swept wing case to demonstrate the full three-dimensional capability. Author

A93-24870#

REAL-TIME OPTICAL MEASUREMENT OF ALKALI SPECIES IN AIR FOR JET ENGINE CORROSION TESTING

K. W. HOLTZCLAW, J. MOORE, and C. L. SENIOR (PSI Technology Co., Andover, MA) Jan. 1993 8 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research sponsored by U.S. Navy refs

(AIAA PAPER 93-0791) Copyright

Measurement of the corrosion potential of engines that must operate in a marine environment is a critical step in procuring new aircraft for the U.S. Navy. Such testing is performed in special engine test cells in which engines are exposed to a saline aerosol. Development of an on-line, non-intrusive measurement can reduce the cost to the Navy of engine testing by reducing the time that the test cell must be operated. We have recently completed a feasibility study for a method of measuring of sodium concentration in aqueous aerosols using laser induced breakdown spectroscopy. This technique is real-time and non-intrusive. In preliminary tests, we have demonstrated the ability to detect from 10 to 6,400 ppb sodium in air. Sub-part-per billion levels of sodium in air can be detected by this method and the measurement was linear over two orders of magnitude in concentration. Author

A93-24872#

DEVELOPMENT OF A SIX COMPONENT FLEXURED TWO SHELL INTERNAL STRAIN GAGE BALANCE

P. J. MOLE (General Dynamics Corp., Convair Div., San Diego, CA) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993

(AIAA PAPER 93-0793) Copyright

The paper describes the development of a new wind tunnel balance designed to meet the load requirements of the new advanced aircraft. Based on the floating frame or two-shell concept, the Flexured Balance incorporates a separate axial element, thus allowing for higher load per unit diameter, reduced primary load interaction, and greater flexibility in load range selection. Described is the design process, fabrication, gaging, calibration results, and performance during tunnel testing of the first prototype balance. Supporting data and accuracies are provided. Author

A93-24979#

STABILITY OF OBLIQUE DETONATIONS IN RAM ACCELERATORS

C. LI, K. KAILASANATH, and E. S. ORAN (U.S. Navy, Naval Research Lab., Washington) Jan. 1992 9 p. AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992 Research supported by USAF and U.S. Navy refs (AIAA PAPER 92-0089)

In order to study combustion mechanisms applicable to RAM accelerators, numerical simulations have been performed for reactive flow-structures generated by oblique shocks in supersonic

hydrogen-oxygen-nitrogen mixtures. Our simulations show complex structures consisting of induction regions, deflagration waves and oblique detonation waves. Such detonation structures can be established on wedge surfaces and are very stable if the flow after combustion is unchoked. The basic configuration of such detonation structures remains very similar in a wide range of flow and mixture conditions while the length scales vary by several orders of magnitude. Author

A93-25198

HELICOPTER PLUME DETECTION BY USING AN ULTRANARROW-BAND NONCOHERENT LASER DOPPLER VELOCIMETER

S. H. BLOOM, P. A. SEARCY, K. CHOI, R. KREMER, and ERIC KOREVAAR (ThermoTrex Corp., San Diego, CA) Optics Letters (ISSN 0146-9592) vol. 18, no. 3 Feb. 1, 1993 p. 244-246. Research sponsored by U.S. Army refs Copyright

An experimental demonstration of helicopter plume detection by using a range-resolved, narrow-bandwidth, noncoherent laser Doppler velocimeter is presented. The laser Doppler velocimeter detects incoming Doppler-shifted signal photons by using the sharp spectral transmission features in a Faraday magneto-optic atomic line filter. Author

A93-25327

VALIDATION OF ELECTROMAGNETIC-TOPOLOGY CONCEPTS ON A COMPLEX STRUCTURE [VALIDATION DES CONCEPTS DE TOPOLOGIE ELECTROMAGNETIQUE SUR UNE STRUCTURE COMPLEXE]

V. GOBIN, F. ISSAC, J. P. APARICIO (ONERA, Chatillon, France), J. P. PARMANTIER (Dassault Aviation, Saint-Cloud, France), I. JUNQUA, A. MADORE, and D. GAUTHIER (DGA, Centre d'Etudes de Gramat, France) ONERA, TP no. 1992-63 1992 7 p. In French. Research supported by DRET refs (ONERA, TP NO. 1992-63)

The paper describes the main results of a series of tests conducted in 1991, in a collaboration between ONERA and CEG, with the aim of demonstrating the feasibility and advantages of the topological analysis of a complex structure. The elements of a modular panel (composed of elementary volumes connected by a network of multifilamentary cables) were characterized by different experimental and theoretical methods. These data were entered into in the CRIPTE code, based on a simulation of an array of multiconductor transmission lines subjected to an electromagnetic disturbance. Numerous experimental results, measured in the frequency and time domains, were obtained in the laboratory and via simulator, and simulated with success by the topological method. B.J.

A93-25346

HIGH TEMPERATURE THIN FILM STRAIN GAUGES

P. KAYSER, J. C. GODEFROY, and L. LECA (ONERA, Chatillon, France) ONERA, TP no. 1992-171 1992 11 p. Research supported by DRET refs (ONERA, TP NO. 1992-171)

The development of thin-film resistance strain gauges suitable for dynamic stress measurements up to 900 C and intended for blade vibration measurements is reported. The strain gauge is deposited by RF sputtering on nickel-base superalloys and consists of an NiCoCrAlY coating, an Al₂O₃ insulating layer, a sensing layer (NiCr, PdCr), an intermediate splicing layer (Pt), and a protective film (Al₂O₃ or SiO₂). The electrical and mechanical properties of the sensing layers and preliminary results on the thermal stability of the gauges are discussed. V.L.

A93-25353

ULTRASONIC THICKNESS MEASUREMENT USING THE ANGLE TECHNIQUE

RICHARD L. TIEFENAUER (Midcoast Aviation, Inc., Cahokia, IL) Materials Evaluation (ISSN 0025-5327) vol. 51, no. 1 Jan. 1993 p. 20, 21. Copyright

The detection of subsurface corrosion in aircraft structures is of great importance in the aircraft industry. This article describes the use of angle-beam ultrasonic techniques to provide direct readings of corrosion depth and location. Readings from an angle-beam transducer were calibrated using results from standard straight-beam thickness inspection. This method of calibration allows direct display of flaw depth during inspections. A.O.

A93-25505#

NUMERICAL INVESTIGATION OF FLOW FIELD IN A TURBINE VOLUTE

MOHAMED ZEDAN, MOHAMED ABOLFADL, ARUN SEHRA (Textron Lycoming, Stratford, CT), and CORRADO PACI (Hispano Suiza, Bois-Colombes, France) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0155) Copyright

This paper presents a numerical investigation of the flow in a turbine exhaust volute using PARC-3D viscous code. Grid refinement studies were conducted to achieve a grid independent solution. A detailed comparison of the predicted and experimental data for total and static pressures at different locations in the volute is presented. Predicted results were generally in good agreement with test data. Based on the understanding of flow physics, recommendations are made for improving the current volute design to reduce total pressure losses and flow separation. PARC-3D viscous code can be used as an analytical tool for refining the turbine volute geometries. Author

A93-25508*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENTAL INVESTIGATIONS OF THE TIME AND FLOW-DIRECTION RESPONSES OF SHEAR-STRESS-SENSITIVE LIQUID CRYSTAL COATINGS

DANIEL C. REDA, JOSEPH J. MURATORE, JR., and JAMES T. HEINECK (NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0181) Copyright

Time and flow-direction responses of shearstress-sensitive liquid crystal coatings were explored experimentally. For the time-response experiments, coatings were exposed to transient, compressible flows created during the startup and off-design operation of an injector-driven supersonic wind tunnel. Flow transients were visualized with a focusing Schlieren system and recorded with a 1000 frame/sec color video camera. Liquid crystal responses to these changing-shear environments were then recorded with the same video system, documenting color-play response times equal to, or faster than, the time interval between sequential frames (i.e., 1 millisecond). For the flow-direction experiments, a planar test surface was exposed to equal-magnitude and known-direction surface shear stresses generated by both normal and tangential subsonic jet-impingement flows. Under shear, the sense of the angular displacement of the liquid crystal dispersed (reflected) spectrum was found to be a function of the instantaneous direction of the applied shear. This technique thus renders dynamic flow reversals or flow divergences visible over entire test surfaces at image recording rates up to 1 KHz. Extensions of the technique to visualize relatively small changes in surface shear stress direction appear feasible. Author

A93-25509#

THE APPLICATION AND ANALYSIS OF LIQUID CRYSTAL THERMOGRAPHS IN SHORT DURATION HYPERSONIC FLOW

H. BABINSKY (Cranfield Inst. of Technology, United Kingdom) and J. A. EDWARDS (Defence Research Agency, Fort Halstead, United Kingdom) Jan. 1993 9 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0182) Copyright

Liquid crystal thermography is applied here in two different hypersonic wind tunnels, a Mach 8 gun tunnel and a Mach 5 blow-down wind tunnel. A technique to extract surface heat transfer levels is introduced. It is shown how the method can be adopted

to the specific difficulties encountered in hypersonic short duration facilities. Digital image processing is used to automatically obtain quantitative information from the liquid crystal experiments, the main features of this process are discussed. Results are shown for a variety of models and the main experimental errors are discussed. Author

A93-25539#

INTERACTION OF A STREAMWISE VORTEX WITH A FREE SURFACE

T. SARPKEYA and D. NEUBERT (U.S. Naval Postgraduate School, Monterey, CA) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by U.S. Navy refs (AIAA PAPER 93-0556)

The results of an experimental investigation on the flow structure resulting from the interaction of a single tip vortex with a deformable free surface are presented. The experiments were conducted in a low-turbulence water tunnel through the use of a half-span rectangular wing, mounted at 12-deg incidence on the tunnel floor. The distance between the tip vortex and the clean free surface was varied systematically. The principal measurements were the mean velocity and turbulence through the use of an LDV system. Photographic observations were made with LIF technique. The results have shown that the free surface redistributes part or all of the normal turbulent kinetic energy into stream-wise and spanwise components. The turbulent kinetic energy first decreases sharply with increasing vertical distance from the vortex and then remains nearly constant within a thin layer below the 'roughened' free surface. Author

A93-25545#

NUMERICAL STUDY OF AN AXISYMMETRIC TURBULENT JET-IMPINGEMENT FLOW

YEU-PIN YEH (Engineering Research & Consulting, Inc., Huntsville, AL), F. B. CHEUNG, KENNETH K. KUO, and THOMAS A. LITZINGER (Pennsylvania State Univ., University Park) Jan. 1993 14 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0652) Copyright

A numerical study was developed to simulate the flow characteristics of a submerged axisymmetric incompressible turbulent jet impinging upon a flat plate. The analysis emphasizes the variations of impinged-wall stress and pressure under different inlet and short-aspect-ratio conditions. Three major regions (i.e., developing free jet, impingement region, and shear-flow wall region) in the jet-impingement flow are numerically predicted and close to the experimental data by using characteristic length scales of free-jet radii. One of the major conclusions is that the empirical results of wall stress and pressure gradient determined by experiments with a high-aspect ratio can be applied to the flow with a low aspect ratio by using free-jet radii. Author

A93-25962

ANALOG SIMULATION AS PART OF A POWER SUPPLY DESIGN ANALYSIS UNIVERSAL PLATFORM

DAVID N. MACLEAN (Boeing Defense and Space Group, Seattle, WA) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 2 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 2.213-2.218. Copyright

The role of analog simulation in the universal computing platform supporting the design of modern switching power conditioning avionics is discussed. An example involving the discontinuous flyback regulator is given. C.D.

A93-25979

JOINING CARBON COMPOSITE FINS TO METAL HEAT PIPES USING ION BEAM TECHNIQUES

ELLIOT B. KENNEL and ARNOLD H. DEUTCHMAN (BeamAlloy Corp., Dublin, OH) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San

Diego, CA, Aug. 3-7, 1992. Vol. 2 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 2.323-2.328. refs Copyright

New types of carbon fiber such as vapor-grown carbon fiber (VGCF) can result in the development of very lightweight composites with very high thermal conductivity. These composites have obvious applications as fin materials for lightweight heat pipe space radiators. The properties of a possible fin/heat interface are analyzed, and ion beam techniques for joining carbon composite fins to metal heat pipes are described. Typical fin performances and pessimistic fin/braze joint performances are listed along with typical VGCF properties. C.D.

A93-26062

FREE-PISTON STIRLING COOLERS FOR INTERMEDIATE LIFT TEMPERATURES

DAVID M. BERCHOWITZ (Sunpower, Inc., Athens, OH) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 5 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 5.115-5.121. refs Copyright

Irreversibilities in Stirling cycle coolers are discussed with reference to designing machines for operation at warmer temperatures rather than cryogenic applications. It is shown that the sensitivity of the cycle to some losses is dependent on the temperature ratio. The free-piston configuration employs a linear motor which greatly reduces side loads and facilitates the implementation of noncontact gas bearings. Mechanism efficiencies are therefore much higher than in crank machines which leads to an overall performance advantage. It is expected that an optimized free-piston Stirling refrigerator cooler could exceed 60 percent of Carnot overall. Author

A93-26064

LINEAR MOTOR DRIVEN STIRLING COOLERS FOR MILITARY AND COMMERCIAL APPLICATIONS

ROBERT BERRY (Hughes Aircraft Co., Los Angeles, CA) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 5 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 5.149-5.154. Copyright

This paper discusses the design and performance of a miniature, closed cycle, split Stirling, cryogenic cooler that provides 1 watt of cooling at 80 K. The compressor uses two opposed linear motors to drive opposed pistons and the expander uses a pneumatically driven displacer. A single electronics module and compressor has been developed to drive three different expanders that have nominal cold cylinder diameters of 5, 8 and 13 mm. Author

A93-26617

THE VIBRATION AND FLUTTER OF COMPOSITE MATERIAL LAMINATE

GUIBIN CHEN and CONGQING ZOU (Beijing Univ. of Aeronautics and Astronautics, China) Acta Materiae Compositae Sinica (ISSN 1000-3851) vol. 9, no. 4 Oct. 1992 p. 1-6. In Chinese. refs

A detailed computation is performed of the vibration and flutter characteristics of composite material laminates with different off-axis angles of plies. Data to be used for aeroelastic tailoring purposes are obtained based on a computation in which the required elastic moduli are provided by fitting the experimental data with the calculated vibration results. Finally, a comparison is made for three kinds of laminates with different plies. Author

A93-26817

DETERMINATION OF NONSTATIONARY AERODYNAMIC LOADING ON CASCADE BLADES IN THE CASE OF DYNAMIC CHANGES OF THE ANGLE OF ATTACK [OPREDELENIE NESTATSIONARNYKH AERODINAMICHESKIKH VOZDEISTVII POTOKA NA LOPATKI RESHETKI PRI DINAMICHESKOM IZMENENII UGLA ATAKI]

A. A. KAMINER, V. A. BALALAEV, G. KH. MINDICH, and V. A. TSIMBALIUK (ANU, Inst. Problem Prochnosti, Kiev, Ukraine) *Problemy Prochnosti* (ISSN 0556-171X) no. 11 1992 p. 71-77. In Russian. refs
Copyright

Experimental equipment for generating flow with a dynamically changing, in accordance with a given law (e.g., sinusoidal), impingement angle is described, and a method is presented for measuring the excitation forces and moments induced by the flow in a cascade. Experimental results are processed on a computer. The approach proposed here makes it possible to compare the experimental data with the available theoretical results. V.L.

A93-26888

DIGITAL MAP DATABASES IN SUPPORT OF AVIONIC DISPLAY SYSTEMS

MICHAEL E. TRENCHARD, MAURA C. LOHRENZ, HENRY ROSCHE, III, and PERRY B. WISCHOW (U.S. Navy, Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS) *In* Large-screen-projection, avionic, and helmet-mounted displays; Proceedings of the Meeting, San Jose, CA, Feb. 26-28, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 318-326. Research supported by U.S. Navy refs
Copyright

Airborne digital moving map systems are being supplied by the Naval Oceanographic and Atmospheric Research Laboratory with CD-ROM Compressed Aeronautical Charts (CACs). The CAC data base furnishes aeronautical chart data in six different scales. Attention is presently given to the tessellated spheroid projection system and down-sampled data compression methods employed; CAC data are 'decompressed' for cockpit display. O.C.

A93-26904

DESIGN OF ADVANCED BEAMS CONSIDERING ELASTO-PLASTIC BEHAVIOUR OF MATERIAL

S. TOLUN (Istanbul Technical Univ., Turkey) *Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee* (ISSN 0035-4074) vol. 37, no. 5 Sept.-Oct. 1992 p. 561-572. refs

The paper proposes a computational procedure for precise calculation of limit and ultimate or design loads, which must be carried by an advanced aviation beam, without permanent distortion and without rupture. Among several stress-strain curve representations, one that is suitable for a particular material is chosen for applied loads, yield, and failure load calculations, and then nonlinear analysis is performed. Author

A93-26999* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EXPERIMENTAL MEASUREMENT OF STRUCTURAL INTENSITY ON AN AIRCRAFT FUSELAGE

J. M. CUSCHIERI (Florida Atlantic Univ., Boca Raton) *Noise Control Engineering Journal* (ISSN 0736-2501) vol. 37, no. 3 Nov.-Dec. 1991 p. 97-107. Research supported by NASA refs
Copyright

An experimental technique was used to measure structural intensity through an aircraft fuselage with an excitation load applied near one of the wing attachment locations. The fuselage was relatively large, requiring several measurement locations to analyze the intensity flow through the whole of the structure. For the measurement of structural intensity, the use of a transducer array was necessary at every location of interest. A trade-off was therefore required between the number of measurement transducers, the mounting of these transducers, and the accuracy of the measurements. Using four accelerometers mounted on a

bakelite platform, structural intensity vectors were measured at locations distributed throughout the fuselage. The results of these measurements, together with a discussion on the suitability of the approach for measuring structural intensity on a real structure, are presented in this paper. Author

A93-27044* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PASSIVE RANGE SENSOR REFINEMENT USING TEXTURE AND SEGMENTATION

BANAVAR SRIDHAR, ANIL PHATAK, and GANO CHATTERJI (NASA, Ames Research Center, Moffett Field, CA) *In* Sensors and sensor systems for guidance and navigation; Proceedings of the Meeting, Orlando, FL, Apr. 2, 3, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 178-189. refs

Copyright

Electrooptical sensors provide a covert way of computing range during helicopter flight. The optical flow-based computation of range provides range information only in certain distinguishable parts of the image. The regions where range information is available can be increased by performing texture analysis and object segmentation in the image. This paper reviews some of the literature on texture segmentation methods with a view towards applying them to images containing both man-made and natural objects at varying ranges. Two algorithmic approaches are given and their application to a real image is demonstrated. Results indicate that it will be necessary to combine several different texture measures and methods in a hierarchical way in order to achieve an object segmentation which is useful in enhancing range information. Author

A93-27045* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A FAST ALGORITHM FOR IMAGE-BASED RANGING

P. K. A. MENON, G. B. CHATTERJI, and B. SRIDHAR (NASA, Ames Research Center, Moffett Field, CA) *In* Sensors and sensor systems for guidance and navigation; Proceedings of the Meeting, Orlando, FL, Apr. 2, 3, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 190-200. refs

(Contract NCC2-575)

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Image-based ranging has emerged as a critical issue in the low altitude operation of flight vehicles such as rotorcraft and planetary landers. These flight regimes require ranging systems for recovering the geometry of the terrain and obstacles for use with guidance algorithms. The development of a ranging equation combining image irradiance together with various order spatial partial derivatives and the vehicle motion parameters is discussed. The ranging equation is in the form of a polynomial in scene depth. Two-dimensional linear filters are then used to compute the coefficients of this polynomial to result in a fast image-based ranging algorithm. Performance of the algorithm is demonstrated using laboratory images. Author

A93-27237

HIGH-RESOLUTION DISPLAYS AND PROJECTION SYSTEMS; PROCEEDINGS OF THE MEETING, SAN JOSE, CA, FEB. 11, 12, 1992

ELLIOTT SCHLAM, ED. and MARKO M. SLUSARCZUK, ED. (DARPA, Washington) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1664) 1992 253 p.

(SPIE-1664; ISBN 0-8194-0818-2) Copyright

The present conference discusses CdSe semiconductors for active matrix displays, integrated driver circuitry for active-matrix liquid-crystal displays (LCDs), novel technologies for tactical aircraft cockpit displays, military high-resolution display requirements, advanced backlighting technologies for LCDs, and a very high resolution virtual display. Also discussed are high-definition head-mounted displays, active-matrix LCD technology for electronic transparencies, optical depixelization for electronic image

projection, a 5-Mpixel CRT monitor, advances in color ac plasma displays, and a holographic electrooptic device. (For individual items see A93-27238 to A93-27242) O.C.

A93-27241
CONTROLS AND DISPLAYS FOR DOUGLAS A-10 FOR THE 1990S

ERWIN ULBRICH (Douglas Aircraft Co., Long Beach, CA) and CURT WALTERS (Honeywell, Inc., Air Transport Systems Div., Phoenix, AZ) /n High-resolution displays and projection systems; Proceedings of the Meeting, San Jose, CA, Feb. 11, 12, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 96-107.

Copyright

Accounts are presented of the current and near-term development status of a major American commercial aircraft manufacturer's integrated cockpit-display systems, as well as the character and anticipated improvements of prospective development trends. The state-of-the-art is illustrated by the cockpit displays of the MD-11 airliner, which employs both CRTs and liquid-crystal displays with a sensor suite that encompasses a dual digital air data system, three separate inertial reference units, X-band weather radar, and radar altimeter. Satellite-based communications and navigation systems are under development. O.C.

A93-27289
ELEMENTARY STALL FLUTTER OF AN AIRCRAFT WING [ELEMENTARNY FLATTER ODERWANIA SKRZYDLA SAMOLOTU]

TOMASZ BARTLER (Inst. Lotnictwa, Warsaw, Poland), JANUSZ NARKIEWICZ (Politechnika Warszawska, Warsaw, Poland), and JACEK SYRYCZYNSKI (WSK Okęcie, Warsaw, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817) no. 103 1991 p. 31-34. In Polish. refs

The dynamic stall model developed by the ONERA is incorporated into calculations of the elementary stall flutter of an aircraft wing. The effect of wing characteristics and stall model coefficients on the onset of flutter is investigated. V.L.

A93-27316
THE EFFECTIVENESS OF POROUS SQUEEZE FILM DAMPERS FOR SUPPRESSING NONSYNCHRONOUS MOTIONS

SHIPING ZHANG, LITANG YAN, and QIHAN LI (Beijing Univ. of Aeronautics and Astronautics, China) ASME, Transactions, Journal of Vibration and Acoustics (ISSN 0739-3717) vol. 115, no. 1 Jan. 1993 p. 16-18. Research supported by NNSFC refs

Copyright

An evaluation is conducted of the effectiveness of porous squeeze-film dampers (PSFDs) in suppressing nonsynchronous motions of gas turbine engine rotors, relative to squeeze-film dampers. It is shown that the PSFD exhibits improved squeeze-film force characteristics, thereby more effectively suppressing nonsynchronous motions with very small transmissibility. Only the synchronous motion of the PSFD system is stable. O.C.

A93-27616
A METHOD FOR CALCULATING THE CHARACTERISTICS OF PLANE COMPRESSOR CASCADES FOR DIFFERENT VALUES OF THE REYNOLDS CRITERION [METOD RASCHETA KHARAKTERISTIK PLOSKIKH KOMPRESSORNYKH RESHETOK PRI RAZLICHNYKH ZNACHENIIAKH KRITERIIA REYNOL'DSA]

A. A. MITROFANOV Aviaatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 64-67. In Russian. refs

Copyright

The paper is concerned with flow through a compressor cascade in the presence of the separation of a laminar boundary layer from the back of the profile. A physical model of the flow is described, and a relatively simple method is developed for calculating losses in compressor (diffuser) cascades for different flow regimes. The characteristics of plane cascades calculated by

the method proposed here are compared with experimental data. V.L.

A93-27620
ESTIMATION OF THE LIFE OF AIRCRAFT STRUCTURES UNDER STOCHASTIC STEADY STATE LOADING [OTSENKA DOLGOVECHNOSTI AVIAKONSTRUKTSII PRI SLUCHAINOM STATSIONARNOM NAGRUZHENII]

V. M. ADROV Aviaatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 79-82. In Russian. refs

Copyright

Formulas are obtained for calculating the fatigue life of aircraft structures with allowance for the reduction of loading sequences to equivalent zero-stress-ratio cycles. Relations are presented which illustrate the effect of loading process characteristics on structural damage. The approach proposed here is shown to provide better approximations of loading processes characteristic of aircraft structures ($k = 2.5-4$) than other analytical methods. V.L.

A93-27628
CALCULATING THE CUTTING DEPTH DURING THE MILLING OF LARGE GAS TURBINE ENGINE BLADES [RASCHET GLUBINY REZANIIA PRI STROCHECHNOM FREZEROVANII KRUPNOGABARITNYKH LOPATOK GTD]

E. M. KOROVIN and A. V. BASHKIRTSEV Aviaatsionnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 105-109. In Russian. refs

Copyright

The cutting depth during milling is investigated in an attempt to solve the problem of the optimal control of the milling of large blades of gas turbine engines. It is shown that the variation of the cutting depth along the cutter path can be as large as 40 percent. A mathematical model, an algorithm, and software are developed for calculating the force applied to the cutter during the milling operation. V.L.

A93-27637
INTERACTION OF TOLLMIE-SCHLICHTING WAVES WITH LOCALIZED DISTURBANCES [VZAIMODEISTVIE VOLN TOLLMINA-SHLIKHTINGA S LOKALIZOVANNYMI VOZMUSHCHENIIAMI]

G. R. GREK and V. V. KOZLOV (RAN, Inst. Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, Russia) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339) no. 5 Sept.-Oct. 1992 p. 68-76. In Russian. refs

Copyright

A particular mechanism of laminar-turbulent transition in connection with a high degree of turbulence of the incoming flow was investigated in a subsonic wind tunnel. It is shown that instability wave packets that are transformed downstream into a turbulent 'spot' are formed during the interaction of T-S waves with puff-type disturbances with roughly equal amplitudes. The puff-type disturbance excites the instability wave packet; the two disturbances then evolve independently of each other. The amplitude spectrum of the instability wave packet has a central frequency that is approximately equal to half the fundamental-wave frequency. L.M.

A93-27782* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

DUAL CONTROL VIBRATION TESTS OF FLIGHT HARDWARE
 TERRY D. SCHARTON (JPL, Pasadena, CA) /n Institute of Environmental Sciences, Annual Technical Meeting, 37th, San Diego, CA, May 6-10, 1991, Proceedings Mount Prospect, IL Institute of Environmental Sciences 1991 p. 68-77. refs

Copyright

A vibration retest of a spacecraft flight instrument, the Mars Observer Camera (MOC), was conducted using extremal dual control to automatically limit the shaker force and notch the shaker acceleration at resonances. This was the first application of extremal dual control with flight hardware at JPL. The retest was successful in that the environment was representative of flight

plus some margin, the instrument survived without any structural or performance degradation, and the force limiting worked very well. The test set-up, force limiting procedure, and test results are described herein. It is concluded that dual control should be utilized when there is a concern about overtesting in hard-base-drive tests and the instrumentation for force measurement and control is available. Recommendations for improving the implementation of dual control are provided as a result of this first experience.

Author

A93-27965

THE DEVELOPMENT AND EVALUATION OF ADVANCED KEVLAR SANDWICH STRUCTURE FOR APPLICATION TO ROTORCRAFT AIRFRAMES

PIERRE MINGUET, STEVEN LLORENTE, and RUSSELL FAY (Boeing Defense & Space Group, Philadelphia, PA) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 18 p. refs

The results of an evaluation of DuPont Kevlar-based material systems in sandwich structure designed for rotorcraft primary airframe structure are presented in this report. The focus of this work has been to evaluate the durability and compression strength of thin-gage Kevlar sandwich panels and investigate means of improvement. It was found that sandwich panels made with Kevlar 149 fibers can be as strong as Kevlar 49 structures but have reduced compression stiffness properties at typical operating strain levels. Thermal cycling was found to affect permeability but not strength in thin facesheet sandwich structure. Any increased permeability can be prevented with the use of an interleaf or surfacing plies. The surfacing plies investigated also had a beneficial effect on sandwich strength due to their stabilizing effect on the facesheet in compression. Finally, a previously developed model was used to analyze the residual strength of a sandwich panel after impact damage.

Author

A93-27968* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN ACCURATE NONLINEAR FINITE ELEMENT ANALYSIS AND TEST CORRELATION OF A STIFFENED COMPOSITE WING PANEL

D. D. DAVIS, JR. (U.S. Army, Aerostructures Directorate, Hampton, VA), T. KRISHNAMURTHY (Analytical Services and Materials, Inc., Hampton, VA), W. J. STROUD (NASA, Langley Research Center, Hampton, VA), and S. L. MCCLEARY (Lockheed Engineering & Sciences Co., Hampton, VA) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. refs

State-of-the-art nonlinear finite element analysis techniques are evaluated by applying them to a realistic aircraft structural component. A wing panel from the V-22 tiltrotor aircraft is chosen because it is a typical modern aircraft structural component for which there is experimental data for comparison of results. From blueprints and drawings, a very detailed finite element model containing 2284 9-node Assumed Natural-Coordinate Strain elements was generated. A novel solution strategy which accounts for geometric nonlinearity through the use of corotating element reference frames and nonlinear strain-displacement relations is used to analyze this detailed model. Results from linear analyses using the same finite element model are presented in order to illustrate the advantages and costs of the nonlinear analysis as compared with the more traditional linear analysis.

Author

A93-27969

NOVEL APPROACHES TO COMPLEX GEOMETRY STRUCTURE

GLENN T. ROSSI (Boeing Defense & Space Group, Philadelphia, PA) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 8 p. Research supported by Boeing Defense & Space Group refs

Each of the four approaches presented for manufacturing

complex-geometry composite structural components for helicopter airframes employs thermoplastic matrices. The single-step manufacture of thermoplastic composite components is the ultimate goal of these investigations; already, producibility is of a level comparable to conventional manufacturing methods. The damage to these components depends on the boundary conditions of an impact event, rather than the interlaminar strength of the laminates. High strain-to-failure fibers optimize performance at the micromechanical level.

O.C.

A93-27970

COUPLED COMPOSITE ROTOR BLADES UNDER BENDING AND TORSIONAL LOADS

RAMESH CHANDRA and INDERJIT CHOPRA (Maryland Univ., College Park) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 20 p. refs

(Contract DAAL03-88-C-0022)

This paper presents an analytical-cum-experimental study of the structural response of composite rotor blades with elastic couplings. Vlasov theory is expanded to analyze two-cell composite rotor blades made out of general composite laminates including the transverse shear deformation of the cross-section. In order to validate this analysis, two-cell graphite-epoxy composite blades with bending-torsion coupling were fabricated using matched-die molding technique. These blades were tested under tip bending and torsional loads, and their structural response in terms of bending slope and twist was measured with a laser optical system. Good correlation between theory and experiment is achieved.

Author

A93-27973

PARAMETRIC STUDY OF THE GEAR BLANK STRUCTURE IN HELICOPTER TRANSMISSION DESIGN

YIH-JEN D. CHEN (McDonnell Douglas Helicopter Co., Mesa, AZ) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 7 p. refs

A prediction method is presented for determining the strength and stiffness of the web and rim structure in the design of transmission gears, giving attention to rim deflection in the specific case of a helicopter transmission that is designed to an optimal size and weight. The results obtained are presented in the form of design charts as well as empirical equations, with a view to such parameters as plate thickness, conical angle, the ratio of inner to outer radius, and rim thickness.

O.C.

A93-27975* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN EXPERIMENTAL AND ANALYTICAL INVESTIGATION ON THE RESPONSE OF GR/EP COMPOSITE I-FRAMES

E. MOAS, JR. (Analytical Services and Materials, Inc., Hampton, VA), R. L. BOITNOTT (U.S. Army, Aviation Research and Technology Activity; NASA, Langley Research Center, Hampton, VA), and O. H. GRIFFIN, JR. (Virginia Polytechnic Inst. and State Univ., Blacksburg) /In AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 27 p. refs

(Contract NAG1-343; NAS1-19317)

Six-foot diameter, semicircular graphite/epoxy specimens representative of generic aircraft frames were loaded quasi-statically to determine their load response and failure mechanisms for large deflections that occur in an airplane crash. These frame-skin specimens consisted of a cylindrical skin section cocured with a semicircular I-frame. Various frame laminate stacking sequences and geometries were evaluated by statically loading the specimen until multiple failures occurred. Two analytical methods were compared for modeling the frame-skin specimens: a two-dimensional branched-shell finite element analysis and a one-dimensional, closed-form, curved beam solution derived using an energy method. Excellent correlation was obtained between

experimental results and the finite element predictions of the linear response of the frames prior to the initial failure. The beam solution was used for rapid parameter and design studies, and was found to be stiff in comparison with the finite element analysis. The specimens were found to be useful for evaluating composite frame designs. Author

A93-27978* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RAPID DETECTION AND QUANTIFICATION OF IMPACT DAMAGE IN COMPOSITE STRUCTURES

JOSEPH N. ZALAMEDA, GARY FARLEY (U.S. Army, Aerostructure Directorate; NASA, Langley Research Center, Hampton, VA), and BARRY T. SMITH (College of William and Mary, Williamsburg, VA) *In* AHS National Technical Specialists' Meeting on Rotorcraft Structures, Williamsburg, VA, Oct. 29-31, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 24 p. refs

(Contract NAG1-1063)

NDE results from thermographic and volumetric ultrasonic techniques are presented to illustrate the multidisciplinary NDE approach to impact-damage detection in such composite structures as are increasingly prevalent in helicopters. Attention is given to both flat-panel and 'y-stiffened' panel specimens; these were fabricated either with kevlar or carbon fiber through-the-thickness reinforcements. While thermal inspection identifies impact damage, volumetric imaging quantifies the impact-generated delaminations through the volume of the structure. O.C.

A93-28151* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SENSORS AND SENSOR SYSTEMS FOR GUIDANCE AND NAVIGATION II; PROCEEDINGS OF THE MEETING, ORLANDO, FL, APR. 22, 23, 1992

SHARON S. WELCH, ED. (NASA, Langley Research Center, Hampton, VA) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1694) 1992 330 p.

(SPIE-1694; ISBN 0-8194-0859-X) Copyright

Topics discussed in this volume include aircraft guidance and navigation, optics for visual guidance of aircraft, spacecraft and missile guidance and navigation, lidar and ladar systems, microdevices, gyroscopes, cockpit displays, and automotive displays. Papers are presented on optical processing for range and attitude determination, aircraft collision avoidance using a statistical decision theory, a scanning laser aircraft surveillance system for carrier flight operations, star sensor simulation for astroinertial guidance and navigation, autonomous millimeter-wave radar guidance systems, and a 1.32-micron long-range solid state imaging ladar. Attention is also given to a microfabricated magnetometer using Young's modulus changes in magnetoelastic materials, an integrated microgyroscope, a pulsed diode ring laser gyroscope, self-scanned polysilicon active-matrix liquid-crystal displays, the history and development of coated contrast enhancement filters for cockpit displays, and the effect of the display configuration on the attentional sampling performance. (For individual items see A93-28152 to A93-28176, A93-28178 to A93-28180) I.S.

**A93-28175
NEW CATHODE-RAY TUBE (CRT) GUN INTERCONNECTION ASSEMBLY**

DAVID M. MCCORMICK (Reynolds Industries, Inc., Los Angeles, CA) *In* Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 222-237. refs

Copyright

A novel interconnection assembly method was developed for the electron gun of airborne CRTs, which makes it possible for the connectors to be connected and disconnected repeatedly (as opposed to soldering as in the conventional method) to provide access to the tube and its interconnecting cable harness.

Environmental tests were conducted on one series of CRTs, which included electrical and environmental conditions which would be experienced in a worst-case aircraft cabin environment, including the altitude, humidity, thermal shock, vibration, and mechanical shock. I.S.

A93-28244

RECENT DEVELOPMENTS IN COMPRESSOR-BASED JOULE-THOMSON COOLING

PAUL BENSON (Dowty Weapon Systems, Gloucester, United Kingdom) *In* Cryogenic optical systems and instruments V; Proceedings of the Meeting, San Diego, CA, July 23, 24, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1993 p. 186-196.

Copyright

Progress made in the development of a range of small compressors and gas cleaning equipment designated High Pressure Pure Air Generators (HiPPAG) is described together with the HiPPAG design considerations and the choice of operation conditions. Particular attention is given to the characteristics of several HiPPAG systems, including a three-stage open-cycle compressor, HiPPAG 100; a four-stage open-cycle compressor, HiPPAG 320; and a three-stage closed-cycle compressor, HiPPAG 340. Design diagrams of HiPPAG 100 and HiPPAG 320 system layouts are presented along with some performance data. I.S.

A93-28279

DEVELOPMENT AND FABRICATION OF AN AUTOCLAVE MOLDED PES/QUARTZ SANDWICH RADOME

LEONARD E. STANTON and STEPHEN D. LEVIN (Texas Instruments, Inc., McKinney) SAMPE Journal (ISSN 0091-1062) vol. 29, no. 2 Mar.-Apr. 1993 p. 33-38.

Copyright

A cohesively bonded, thermoplastic composite sandwich radome for a leading edge supersonic aircraft has been built using autoclave processing with PES/Quartz prepreg and a PES coated honeycomb core. Processes were developed for solvent removal, thermoplastic laminate consolidation, surface etching to improve adhesion, honeycomb coating and forming, and ultrasound testing of bond integrity. Environmental testing was also conducted to verify the structural integrity of the radome for its intended application. Author

A93-28290

FRACTURE OF HIGHWAY AND AIRPORT PAVEMENTS

D. V. RAMSAMOOJ (California State Univ., Fullerton) Engineering Fracture Mechanics (ISSN 0013-7944) vol. 44, no. 4 March 1993 p. 609-626. refs

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Existing solutions for the stresses in a cracked slab containing a crack and supported by an elastic foundation are extended to obtain the stress intensity factor (SIF) for a crack in a pavement subjected to moving vehicular loads. In the existing solutions the stresses can be obtained only for a uniform bending stress (before the crack occurs) along the crack surface. For pavements subjected to moving vehicular loads, the stress distribution along the crack surface is not uniform and the approximation of a uniform stress is often unsatisfactory. The present work extends the above solutions to cover more realistic loading of highway and airport pavements. This facilitates the application of the principles of fracture mechanics to the fatigue crack propagation and fracture of pavements. Beginning with a part-through semi-elliptical starter crack, the crack is assumed to grow under load and the SIF is presented at various stages of crack growth, from the starter crack into a short through-crack that eventually becomes a very long through-crack. Some examples of the fracture of typical rigid and flexible highway and airport pavements are presented to show the need to consider fracture in the design of pavements.

Author

A93-28291

CRACK GROWTH AND REPAIR OF MULTI-SITE DAMAGE OF FUSELAGE LAP JOINTS

L. MOLENT and R. JONES (Defence Science and Technology Organisation, Aeronautical Research Lab., Fishermens Bend, Australia) *Engineering Fracture Mechanics* (ISSN 0013-7944) vol. 44, no. 4 March 1993 p. 627-637. refs
Copyright

A fatigue test program was conducted to investigate multi-site damage of commercial wide-bodied aircraft fuselage lap joints. Crack growth data were generated using specimens representative of a typical lap joint. It was also demonstrated that a boron/epoxy composite doubler, bonded over the joint, could significantly increase the fatigue life of such structures. Author

A93-28543* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

GLOBAL/LOCAL INTERLAMINAR STRESS ANALYSIS OF A GRID-STIFFENED COMPOSITE PANEL

J. F. M. WIGGENRAAD (National Aerospace Lab., Emmeloord, Netherlands) and N. R. BAULD, JR. (Clemson Univ., SC) *Journal of Reinforced Plastics and Composites* (ISSN 0731-6844) vol. 12, no. 2 Feb. 1993 p. 237-253. Previously announced in STAR as N92-33139 refs
(Contract NAS1-17925)
Copyright

A global/local procedure for the computation of the interlaminar stress components at the skin wrap, skin core, and wrap core interfaces for an advanced concept stiffened panel, is described. The procedure consists of a global model of two dimensional shell elements that is used to design a grid stiffened panel with blade type stiffeners, a local model of three dimensional solid elements that is used to compute interlaminar stress components, and a scheme devised to assign displacement boundary conditions for a local model that are based on displacement and rotation data of a few nodes of the global model. A global panel was designed according to strength, stiffness, and stability criteria associated with the design of traditional aircraft wing panels. Interlaminar normal and shearing stress components, computed via the local model, were found to be well below typical tensile normal and shearing strengths of a graphite epoxy material. Author

A93-28567

ANALYSIS OF THE FRICTION AND WEAR MECHANISMS OF MULTILAYERED PLASMA-SPRAYED CERAMIC COATINGS

JEN F. LIN and TZUEN R. LI (National Cheng Kung Univ., Tainan, Taiwan) *Wear* (ISSN 0043-1648) vol. 160, no. 2 Feb. 1, 1993 p. 201-212. refs
Copyright

Wear tests were conducted on a rotor-vane-disk adaptor where three rotating vanes were pressed against a disk. Vanes were coated by WC and used as the upper specimen while the disk was coated by Cr₂O₃ and used as the lower specimen. A buffer layer of various thicknesses and contents was placed between the top coating and the bulk steel of the disk to alleviate the effects of the large difference in thermal properties of the two materials. The experimental results reveal that correct placement of a buffer layer can indeed improve the wear resistance. Factors such as the temperature to which the specimen was heated before testing, the proportion by weight of each individual constituent in the buffer layer, and the thickness of each coating layer, were also important for the volume of wear of the lower specimen. Elevating the preheating temperature of the specimens can diminish the wear volume but increases the friction coefficient. Brittle fracture, abrasion, adhesion, and oxidation were found to be the primary wear mechanisms in the tests. Author

A93-28575

THE COHERENT STRUCTURE IN A CORNER TURBULENT BOUNDARY LAYER

IKUO NAKAMURA (Nagoya Univ., Japan), MASAFUMI MIYATA (Yamanashi Univ., Kofu, Japan), TAKEHIRO KUSHIDA (Nagoya Univ., Japan), and TAKEHITO YAMAGUCHI (Matsushita Electric Industrial Co., Ltd., Tokyo, Japan) *Nagoya University, Faculty of*

Engineering, Memoirs (ISSN 0027-7657) vol. 44, no. 1 1992 p. 135-146. refs

The turbulent boundary layer developing along a corner formed by two perpendicular flat plates is examined to clarify the effect of Prandtl's second kind secondary flow on the bursting phenomenon and space correlation contour. Bursting was detected by use of VITA method. Comparison of the two bursting processes of which one is detected far from the corner and the other is detected near the corner has shown definitely the effect of the corner on the bursting process. The space correlation contours have shown the eddy becomes smaller near the corner than that found far from the corner. Author

A93-28615

STRUCTURAL ANALYSIS OF BOX BEAMS USING SYMBOLIC MANIPULATION TECHNIQUE

M. SATHYAMOORTHY and RAVINDRA SIRIGIRI (Clarkson Univ., Potsdam, NY) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 262-267. Research supported by IPA refs

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The aeroelastic analysis of aircraft wings requires an accurate determination of the influence coefficients. In the past, energy methods have been commonly used to analyze box-type structures and the results have been found to agree well with the experiments. However, when analysis of large wing-type structures is desired, it becomes necessary to automate the energy method. In this article, a method has been developed based on symbolic manipulation as an automated technique to find solutions to box-type structures. Various manipulations required for the energy method have been automatically implemented in a computer program with solutions available at each stage in a symbolic form. The numerical results for several example problems have been compared with alternate theoretical as well as experimental results. Good agreement has been noted in all the cases considered in this article. Author

A93-28618* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SENSITIVITY-BASED SCALING FOR APPROXIMATING STRUCTURAL RESPONSE

KWAN J. CHANG (Lockheed Engineering & Sciences Co., Hampton, VA), RAPHAEL T. HAFTKA (Virginia Polytechnic Inst. and State Univ., Blacksburg), GARY L. GILES (NASA, Langley Research Center, Hampton, VA), and PI-JEN KAO (Analytical Services and Materials, Inc., Hampton, VA) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 283-288. Previously cited in issue 12, p. 1987, Accession no. A91-31855 refs

(Contract NAG1-224)

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A93-28749

NONSTEADY, ONE-DIMENSIONAL, INTERNAL, COMPRESSIBLE FLOWS - THEORY AND APPLICATIONS

JOHN A. C. KENTFIELD (Calgary Univ., Canada) New York Oxford University Press (Oxford Engineering Science Series. Vol. 31) 1993 299 p. refs
(ISBN 0-19-507358-4) Copyright

The present treatment of nonsteady compressible internal flows gives attention to practical applications of this theory. A generalized method-of-characteristics as applied to 1D nonsteady internal flows is first given, followed by the various boundary conditions needed for handling practical problems. Families of devices treated encompass pressure-exchangers, pulse combustors, induction and exhaust-system tuning, and such interesting nonsteady flow devices as thrust augmentors and detonation-wave combustors. O.C.

A93-29258

ENHANCEMENTS TO MODAL TESTING USING FINITE ELEMENTS

BRIAN JARVIS (PAFEC, Ltd., Bristol, United Kingdom) *In International Modal Analysis Conference (IMAC), 9th, Florence,*

Italy, Apr. 15-18, 1991, Proceedings. Vol. 1 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 402-408. refs Copyright

In calculating the natural frequencies and mode shapes from a finite element analysis, there are generally many more degrees of freedom than can be handled for the eigensolution. A reduction process is employed to reduce the number to a master set and chosen so that the modes of interest are well defined. By choosing those freedoms where the inertia terms are high or the stiffness terms are low then an automatic procedure for selecting the best freedoms can be defined. For modal testing, these master freedoms also indicate the best transducer locations for optimum low order mode identification. Having carried out the modal test, the mode shapes obtained can be forced onto the finite element model giving greatly enhanced results. By examining terms in all mode shapes from the finite element model in the frequency range of interest, the best reference or excitation position can be found. An example of the use of this technique to study the modal properties of an aero-engine compressor blade is given. Author

A93-29264
EXPANDING TEST MODE SHAPES FOR BETTER VISUALIZATION

STEVEN M. CROWLEY (Structural Dynamics Research Corp., Milford, OH) /In International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 1 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 492-498. refs Copyright

Three techniques for expanding the information at the measured test degrees of freedom are presented. The first technique consists of writing constraint equations between existing measurement locations to fill in unmeasured degrees of freedom. The second technique uses an existing finite element model to back-expand the test degrees of freedom to full finite element representation. And the third technique uses a trivariate interpolation scheme to map the results from one set of discrete geometric points to a new set of geometry. I.S.

A93-29293* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

THERMOELASTIC VIBRATION TEST TECHNIQUES

MICHAEL W. KEHOE (NASA, Flight Research Center, Edwards, CA) and H. T. SNYDER (Planning Research Corp., Edwards, CA) /In International Modal Analysis Conference (IMAC), 9th, Florence, Italy, Apr. 15-18, 1991, Proceedings. Vol. 2 Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 1473-1484. Previously announced in STAR as N91-19083 refs

The structural integrity of proposed high speed aircraft can be seriously affected by the extremely high surface temperatures and large temperature gradients throughout the vehicle's structure. Variations in the structure's elastic characteristics as a result of thermal effects can be observed by changes in vibration frequency, damping, and mode shape. Analysis codes that predict these changes must be correlated and verified with experimental data. The experimental modal test techniques and procedures used to conduct uniform, nonuniform, and transient thermoelastic vibration tests are presented. Experimental setup and elevated temperature instrumentation considerations are also discussed. Modal data for a 12 by 50 inch aluminum plate heated to a temperature of 475 F are presented. These data show the effect of heat on the plate's modal characteristics. The results indicated that frequency decreased, damping increased, and mode shape remained unchanged as the temperature of the plate was increased.

Author

A93-29301
AERODYNAMIC APPLICATIONS OF PRESSURE SENSITIVE PAINT

M. J. MORRIS, J. F. DONOVAN, J. T. KEGELMAN, S. D. SCHWAB, R. L. LEVY (McDonnell Douglas Research Labs., Saint Louis, MO), and R. C. CRITES (McDonnell Aircraft Co., Saint Louis, MO) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p.

419-425. Previously cited in issue 09, p. 1422, Accession no. A92-25720 Research supported by McDonnell Douglas Independent Research and Development Program refs Copyright

A93-29302* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AERO-OPTICAL PHASE MEASUREMENTS USING FOURIER TRANSFORM HOLOGRAPHIC INTERFEROMETRY

GEORGE HAVENER and DENISE KIRBY (Calspan Corp., Arnold AFB, TN) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 426-433. Previously cited in issue 09, p. 1424, Accession no. A92-26237 Research supported by U.S. Army, USAF, and NASA refs

A93-29304
APPLICATION OF PARTICLE IMAGE VELOCIMETRY IN HIGH-SPEED SEPARATED FLOWS

M. J. MOLEZZI and J. C. DUTTON (Illinois Univ., Urbana) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 438-446. Previously cited in issue 07, p. 1058, Accession no. A92-22129 Research supported by U.S. Army refs Copyright

A93-29308* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PROGRESS IN LASER SPECTROSCOPIC TECHNIQUES FOR AERODYNAMIC MEASUREMENTS - AN OVERVIEW

ROBERT L. MCKENZIE (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 465-477. Previously cited in issue 07, p. 1046, Accession no. A91-21351 refs Copyright

A93-29315* National Aeronautics and Space Administration, Washington, DC.

LASER SELECTION CRITERIA FOR OH FLUORESCENCE MEASUREMENTS IN SUPERSONIC COMBUSTION TEST FACILITIES

T. M. QUAGLIAROLI, G. LAUFER, R. H. KRAUSS, and J. C. MCDANIEL, JR. (Virginia Univ., Charlottesville) AIAA Journal (ISSN 0001-1452) vol. 31, no. 3 March 1993 p. 520-527. Previously cited in issue 10, p. 1614, Accession no. A92-26935 refs (Contract NGT-50714) Copyright

A93-29426
TRANSMISSION ERROR AND LOAD DISTRIBUTION ANALYSIS OF SPUR AND DOUBLE HELICAL GEAR PAIRS USED IN A SPLIT PATH HELICOPTER TRANSMISSION DESIGN

DAVID HOCHMANN, DONALD R. HOUSER, and JACOB THOMAS (Ohio State Univ., Columbus) /In AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 14 p. Research supported by Sikorsky Aircraft, U.S. Army, and Ohio State Univ refs Copyright

Because the reduction of gear noise in next-generation rotorcraft depends on the reduction of transmission errors, attention is presently given to the prediction of such errors and the load distributions of both a spur-gear pair and a double helical gear train used in a split-path helicopter transmission. Two cases are examined: (1) the spur gear mesh between the spur shaft and the lower spur/helical shaft, and (2) the double helical gear mesh between the lower spur/helical shaft and the output bull bear shaft. O.C.

A93-29485* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE MICROSTRIP PROPORTIONAL COUNTER

B. D. RAMSEY (NASA, Marshall Space Flight Center, Huntsville,

AL) *In* EUV, X-ray, and gamma-ray instrumentation for astronomy III; Proceedings of the Meeting, San Diego, CA, July 22-24, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 96-103. refs

Copyright

Microstrip detectors in which the usual discrete anode and cathode wires are replaced by conducting strips on an insulating or partially insulating substrate are fabricated using integrated circuit-type photolithographic techniques and hence offer very high spatial accuracy and uniformity, together with the capability of producing extremely fine electrode structures. Microstrip proportional counters have now been variously reported having an energy resolution of better than 11 percent FWHM at 5.9 keV. They have been fabricated with anode bars down to 2 microns and on a variety of substrate materials including thin films which can be molded to different shapes. This review will examine the development of the microstrip detector with emphasis on the qualities which make this detector particularly interesting for use in astronomy. Author

A93-29718

INTERACTION OF COMPRESSION WAVES WITH AN ELASTIC SPHERICAL DOME [VZAIMODEISTVIE VOLNY SZHATIIA S UPRUGIM SFERICHESKIM KUPOLOM]

V. M. ZAKALIUKIN and N. V. TSEKHMISTROVA *In* Certain problems of the dynamics of mechanical systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 60-64. In Russian.

Copyright

Simple models are proposed for the aeroelastic problem of the interaction of a weak shock wave with a thin shell. A method for calculating averaged loads in the case of the action of a weak shock on a spherical dome, developed previously by the authors (1989), is used to determine the displacement of points on the elastic dome and to calculate the shear stress on the shell's frame. In addition, formulas are obtained for calculating excess pressures associated with the passage of a shock wave through the elastic shell, taking transmitted and reflected waves into account. These formulas make it possible to develop a more precise aeroelastic model of wave/dome interaction. L.M.

N93-19771# Istanbul Univ. (Turkey).

ADVANCES IN SPEECH PROCESSING

A. NEJAT INCE *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface 14 p Oct. 1992

Copyright Avail: CASI HC A03/MF A03

The field of speech processing is undergoing a rapid growth in terms of both performance and applications and this is fueled by the advances being made in the areas of microelectronics, computation, and algorithm design. The use of voice for civil and military communications is discussed considering advantages and disadvantages including the effects of environmental factors such as acoustic and electrical noise and interference and propagation. The structure of the existing NATO communications network and the evolving Integrated Services Digital Network (ISDN) concept are briefly reviewed to show how they meet the present and future requirements. The paper then deals with the fundamental subject of speech coding and compression. Recent advances in techniques and algorithms for speech coding now permit high quality voice reproduction at remarkably low bit rates. The subject of speech synthesis is next treated where the principle objective is to produce natural quality synthetic speech from unrestricted text input. Speech recognition where the ultimate objective is to produce a machine which would understand conversational speech with unrestricted vocabulary, from essentially any talker, is discussed. Algorithms for speech recognition can be characterized broadly as pattern recognition approaches and acoustic phonetic approaches. To date, the greatest degree of success in speech recognition has been obtained using pattern recognition paradigms. It is for this reason that the paper is concerned primarily with this technique. Author

N93-19925# Office National d'Etudes et de Recherches Aérospatiales, Paris (France). Direction des Etudes de Synthèse.

RAMSES: MULTI-SPECTRAL EXPERIMENTAL RADAR STATION INSTALLED ON BOARD THE TRANSALL [RAMSES: STATION RADAR EXPERIMENTALE MULTI-SPECTRALE EMBARQUEE SUR TRANSALL]

J. M. BOUTRY and D. LECOZ *In* AGARD, Flight Testing 8 p Oct. 1992 In FRENCH

Copyright Avail: CASI HC A02/MF A04

Within the context of studies devoted to onboard radar applications (missiles, aircraft, satellites, etc.), ONERA is developing and implementing, with the support of the General Delegation for Armament and in collaboration with the Flight Testing Center of Bretigny, a radar experimental station installed onboard a Transall. This permits a parametric study of the radar operating modes and the associated methods of signal processing. The areas in which the station is used are introduced, while examining in particular the problem of the transposition of the radar and geometric parameters. Then, the main technical features of the station are reviewed. Finally, a few examples of the preliminary results are described. Author

N93-19927# British Aerospace Defence, Preston (England).

DEVELOPMENT AND FLIGHT TESTING OF A SURFACE PRESSURE MEASUREMENT INSTALLATION ON THE EAP DEMONSTRATOR AIRCRAFT

G. J. WATSON *In* AGARD, Flight Testing 13 p Oct. 1992

Copyright Avail: CASI HC A03/MF A04

This paper describes a project to develop and flight test a surface pressure measurement system on the UK Experimental Aircraft Program demonstrator aircraft. The paper begins with a brief description of the potential benefits of developing such a system. This is followed by the results and conclusions of development tests involving Wind Tunnel measurements and some preliminary Flight Trials. The installation details for the main Flight Test Trials are then described and the final results from the system are presented, compared with predictions based on previous Wind Tunnel measurements. The capability of the system to provide pressure distribution data of interest to the Aerodynamicist and integrated component loads for Flight Clearance purposes is demonstrated, and its usefulness as a Flight Testing technique is discussed. Author

N93-19971# Sverdrup Technology, Inc., Brook Park, OH. Research Center Group.

MULTIDISCIPLINARY TAILORING OF HOT COMPOSITE STRUCTURES

SURENDRA N. SINGHAL and CHRISTOS C. CHAMIS (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.) Cleveland, OH Feb. 1993 20 p Proposed for presentation at the 33rd Structures, Structural Dynamics and Materials Conference, Dallas, TX, 13-15 Apr. 1993; cosponsored by the AIAA, ASME, ASCE, AHS, and ASC Previously announced in IAA as A92-34564

(Contract RTOP 505-62-53)

(NASA-TM-106027; E-7589; NAS 1.15:106027) Avail: CASI HC A03/MF A01

A computational simulation procedure is described for multidisciplinary analysis and tailoring of layered multi-material hot composite engine structural components subjected to simultaneous multiple discipline-specific thermal, structural, vibration, and acoustic loads. The effect of aggressive environments is also simulated. The simulation is based on a three-dimensional finite element analysis technique in conjunction with structural mechanics codes, thermal/acoustic analysis methods, and tailoring procedures. The integrated multidisciplinary simulation procedure is general-purpose including the coupled effects of nonlinearities in structure geometry, material, loading, and environmental complexities. The composite material behavior is assessed at all composite scales, i.e., laminate/ply/constituents (fiber/matrix), via a nonlinear material characterization hygro-thermo-mechanical model. Sample tailoring cases exhibiting nonlinear material/loading/environmental behavior of aircraft engine fan

blades, are presented. The various multidisciplinary loads lead to different tailored designs, even those competing with each other, as in the case of minimum material cost versus minimum structure weight and in the case of minimum vibration frequency versus minimum acoustic noise. Author

N93-19999# Scientific Research Associates, Inc., Glastonbury, CT.

PROJECTILE BASE BLEED TECHNOLOGY. PART 2: USER'S GUIDE CMINT COMPUTER CODE, VERSION 5.04-BRL Final Report, Jul. 1988 - Jul. 1991

HOWARD J. GIBELING and RICHARD C. BUGGELN Nov. 1992 126 p

(Contract DAA15-88-C-0040)

(AD-A258630; R91-930020F; ARL-CR-3) Avail: CASI HC A07/MF A02

Detailed finite rate chemistry models for H₂ and H₂-CO combustion have been incorporated into a Navier-Stokes computer code and applied to flow field simulation in the base region of an M864 base burning projectile. Results without base injection were obtained using a low Reynolds number k-epsilon turbulence model and several mixing length turbulence models. The results with base injection utilized only the Baldwin-Lomax model for the Projectile forebody and the Chow wake mixing model downstream of the projectile base. A validation calculation was performed for a supersonic hydrogen-air burner using an H₂ reaction set which is a subset of the H₂-CO reaction set developed for the base combustion modeling. The comparison with the available experimental data was good, and provides a level of validation for the technique and code developed. Projectile base injection calculations were performed for a flat base M864 projectile at $M(\infty) = 2$. Hot air injection, H₂ injection and H₂-CO injection were modeled, and computed results show reasonable trends in the base pressure increase (base drag reduction), base corner expansion and downstream wake closure location. GRA

N93-20057*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL SIMULATION OF A HIGH MACH NUMBER JET FLOW

M. EHTESHAM HAYDER, ELI TURKEL, and REDA R. MANKBADI Jan. 1993 17 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA

(Contract RTOP 505-62-21)

(NASA-TM-105985; E-7509; NAS 1.15:105985; AIAA PAPER 93-0653; ICOMP-92-26) Avail: CASI HC A03/MF A01

The recent efforts to develop accurate numerical schemes for transition and turbulent flows are motivated, among other factors, by the need for accurate prediction of flow noise. The success of developing high speed civil transport plane (HSCT) is contingent upon our understanding and suppression of the jet exhaust noise. The radiated sound can be directly obtained by solving the full (time-dependent) compressible Navier-Stokes equations. However, this requires computational storage that is beyond currently available machines. This difficulty can be overcome by limiting the solution domain to the near field where the jet is nonlinear and then use acoustic analogy (e.g., Lighthill) to relate the far-field noise to the near-field sources. The later requires obtaining the time-dependent flow field. The other difficulty in aeroacoustics computations is that at high Reynolds numbers the turbulent flow has a large range of scales. Direct numerical simulations (DNS) cannot obtain all the scales of motion at high Reynolds number of technological interest. However, it is believed that the large scale structure is more efficient than the small-scale structure in radiating noise. Thus, one can model the small scales and calculate the acoustically active scales. The large scale structure in the noise-producing initial region of the jet can be viewed as a wavelike nature, the net radiated sound is the net cancellation after integration over space. As such, aeroacoustics computations are highly sensitive to errors in computing the sound sources. It is therefore essential to use a high-order numerical scheme to predict the flow field. The present paper presents the

first step in an ongoing effort to predict jet noise. The emphasis here is in accurate prediction of the unsteady flow field. We solve the full time-dependent Navier-Stokes equations by a high order finite difference method. Time accurate spatial simulations of both plane and axisymmetric jet are presented. Jet Mach numbers of 1.5 and 2.1 are considered. Reynolds number in the simulations was about a million. Our numerical model is based on the 2-4 scheme by Gottlieb & Turkel. Bayliss et al. applied the 2-4 scheme in boundary layer computations. This scheme was also used by Ragab and Sheen to study the nonlinear development of supersonic instability waves in a mixing layer. In this study, we present two dimensional direct simulation results for both plane and axisymmetric jets. These results are compared with linear theory predictions. These computations were made for near nozzle exit region and velocity in spanwise/azimuthal direction was assumed to be zero. Author

N93-20230# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

TOPOLOGICAL APPROACH FOR THE STUDY OF ELECTROMAGNETIC COUPLING Ph.D. Thesis - Univ. des Sciences et Techniques de Lille [APPROCHE TOPOLOGIQUE POUR L'ETUDE DES COUPLAGES ELECTROMAGNETIQUES]

JEAN-PHILIPPE PARMANTIER 1992 350 p In FRENCH (ISSN 0078-379X)

(ONERA-P-1992-2; ETN-93-93044) Avail: CASI HC A15/MF A03

A topological approach used to study electromagnetic coupling on global terms on an aircraft is presented. Descriptive topology concepts are presented. It is shown how this descriptive analysis can be used to structure the quantitative analysis of the coupling. Wiring topology is studied because it lends itself perfectly to the applications in the multiconductor transmission line network formalism. A computer code was developed for these applications. The formalism is generalized to structures other than lines by calculating scattering parameters for several aperture coupling configurations. The results are validated with two experiments in complex structures. The approach is suitable to describe the electromagnetic coupling of aircraft instruments, in order to improve aircraft design and research in the field of electromagnetic compatibility. ESA

N93-20268*# Toledo Univ., OH. Dept. of Mechanical Engineering.

ANALYSIS AND EVALUATION OF AN INTEGRATED LAMINAR FLOW CONTROL PROPULSION SYSTEM Final Technical Report

THEO G. KEITH, JR. and KENNETH J. DEWITT Feb. 1993 53 p

(Contract NAG3-937)

(NASA-CR-192162; NAS 1.26:192162) Avail: CASI HC A04/MF A01

Reduction of drag has been a major goal of the aircraft industry as no other single quantity influences the operating costs of transport aircraft more than aerodynamic drag. It has been estimated that even modest reduction of frictional drag could reduce fuel costs by anywhere from 2 to 5 percent. Current research on boundary layer drag reduction deals with various approaches to reduce turbulent skin friction drag as a means of improving aircraft performance. One of the techniques belonging to this category is laminar flow control in which extensive regions of laminar flow are maintained over aircraft surfaces by delaying transition to turbulence through the ingestion of boundary layer air. While problems of laminar flow control have been studied in some detail, the prospect of improving the propulsion system of an aircraft by the use of ingested boundary layer air has received very little attention. An initial study for the purpose of reducing propulsion system requirements by utilizing the kinetic energy of boundary layer air was performed in the mid-1970's at LeRC. This study which was based on ingesting the boundary layer air at a single location, did not yield any significant overall propulsion benefits; therefore, the concept was not pursued further. However, since then it has been proposed that if the boundary layer air were ingested at various locations on the aircraft surface instead of

just at one site, an improvement in the propulsion system might be realized. The present report provides a review of laminar flow control by suction and focuses on the problems of reducing skin friction drag by maintaining extensive regions of laminar flow over the aircraft surfaces. In addition, it includes an evaluation of an aircraft propulsion system that is augmented by ingested boundary layer air. Derived from text

N93-20289 North Carolina State Univ., Raleigh.
MEAN FLOW INTERACTIONS OF A COUNTER-ROTATING PROPELLER Ph.D. Thesis

JIN-DEOG CHUNG 1992 163 p
 Avail: Univ. Microfilms Order No. DA9300007

The aerodynamic interaction between the forward and rear rotors in a counter rotating (CRP) system, has been examined using a double conditional sampling methodology applied to 3-D thermal anemometer data. The technique effectively freeze the rotors in any desired relative position and provides the inter-rotor flow field. Axial, radial and circumferential steady mean flow between rotors is shown relative to the 'fixed' forward rotor for various 'fixed' rear rotor positions. The effects of the upstream disturbance from the rear rotor on the wakes of the forward rotor blades have been documented. This disturbance occurs in all three flow components and varies with distance from the rear rotor and with radial location. Modulations of the forward wakes depend upon the relative rear rotor locations. As the rear rotor continues to rotate past the forward blade, the location of the peak velocity from the forward blades moves circumferentially and springs back as the cycle repeats for the next rear blade. This is a 'wiggling' motion. Double conditional sampling is also used to evaluate the determining CRP flow field by superposing the flow that would occur as a result of the forward and rear rotors operating separately. Simulation of conditions on both rotors that occur in the CRP configuration is attempted by duplicating alternately RPM's, inflow conditions, angles of attack and power and thrust coefficients. The superposition for the various single rotor operating conditions does not yield an acceptable accuracy of wave forms and magnitude simultaneously. The velocity vectors of the cross-stream component show that superposition does not produce the identical flow direction and magnitude of the actual flow. Dissert. Abstr.

N93-20297* Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
METHODOLOGY FOR SENSITIVITY ANALYSIS, APPROXIMATE ANALYSIS, AND DESIGN OPTIMIZATION IN CFD FOR MULTIDISCIPLINARY APPLICATIONS Progress Report, 15 Apr. 1992 - 31 Jan. 1993
 ARTHUR C. TAYLOR, III and GENE W. HOU Feb. 1993 36 p
 (Contract NAG1-1265)
 (NASA-TR-192172; NAS 1.26:192172) Avail: CASI HC A03/MF A01

In this study involving advanced fluid flow codes, an incremental iterative formulation (also known as the delta or correction form) together with the well-known spatially-split approximate factorization algorithm, is presented for solving the very large sparse systems of linear equations which are associated with aerodynamic sensitivity analysis. For smaller 2D problems, a direct method can be applied to solve these linear equations in either the standard or the incremental form, in which case the two are equivalent. Iterative methods are needed for larger 2D and future 3D applications, however, because direct methods require much more computer memory than is currently available. Iterative methods for solving these equations in the standard form are generally unsatisfactory due to an ill-conditioning of the coefficient matrix; this problem can be overcome when these equations are cast in the incremental form. These and other benefits are discussed. The methodology is successfully implemented and tested in 2D using an upwind, cell-centered, finite volume formulation applied to the thin-layer Navier-Stokes equations. Results are presented for two sample airfoil problems: (1) subsonic low Reynolds number laminar flow; and (2) transonic high Reynolds number turbulent flow. Author

N93-20299* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL PARAMETRIC STUDY OF SIDEWALL-COMPRESSION SCRAMJET INLET PERFORMANCE AT MACH 10
 SCOTT D. HOLLAND Washington Feb. 1993 14 p
 (Contract RTOP 506-40-71-04)
 (NASA-TM-4411; L-17134; NAS 1.15:4411) Avail: CASI HC A03/MF A01

A computational parametric study of three-dimensional, sidewall-compression scramjet inlets was performed to identify the effects of geometric parameters on inlet performance. The parameters were the leading-edge sweep angle, varied between 30 and 60 deg, and the leading-edge position of the cowl, located at the throat and at two forward positions. A laminar boundary layer with cold-wall ($T_{\text{sub wall}} = 300 \text{ K}$ (540 R)) boundary conditions was imposed. The parametric study was performed for a Mach number of 10 and a unit free-stream Reynolds number of 7.06×10^6 per meter (2.15×10^6 per foot) at a geometric contraction ratio of 5. The performance of each configuration was evaluated in terms of the mass capture, throat Mach number, total pressure recovery, kinetic energy efficiency, and internal compression. One computation of an unswept configuration was included as a baseline to determine the effects of introducing leading-edge sweep on the flow-field parameters. The purpose of the computational parametric study was to perform a trade-off of the effects of various parameters on the global performance of the inlet. Although no single optimal configuration emerged, trade-offs among the stated performance parameters identified a leading-edge sweep angle of 45 deg as possessing the most attractive performance characteristics. Author

N93-20368* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STRUCTURAL DYNAMICS BRANCH RESEARCH AND ACCOMPLISHMENTS TO FY 1992
 CHARLES LAWRENCE Dec. 1992 39 p
 (Contract RTOP 505-63-513)
 (NASA-TM-105824; E-7237; NAS 1.15:105824) Avail: CASI HC A03/MF A01

This publication contains a collection of fiscal year 1992 research highlights from the Structural Dynamics Branch at NASA LeRC. Highlights from the branch's major work areas--Aeroelasticity, Vibration Control, Dynamic Systems, and Computational Structural Methods are included in the report as well as a listing of the fiscal year 1992 branch publications. Author

N93-20573 British Broadcasting Corp., Kingswood (England). Engineering Div.
HELITRAK: A HELICOPTER-TRACKING RECEIVER SYSTEM FOR TELEVISION OUTSIDE BROADCAST LINKS
 C. GANDY 1992 19 p
 (BBC-RD-1992/5) Copyright Avail: BBC, Kingswood Warren, Tadworth, Surrey, England

Helicopters are used by BBC Television for certain live outside broadcasts which require an elevated platform for a camera or for a radio-link mid-point repeater. Video signals are communicated from the helicopter to the ground using microwave radio links, and the signals are received by a narrow-beamwidth dish antenna which must be kept pointing accurately towards the aircraft. In the past, this receiving antenna has always been pointed manually, but in some circumstances the performance of the radio links can be limited by the ability of an operator to keep the antenna on track. Such a limitation can be avoided by using an automatic tracking system; this report describes the approach taken by the Research Department to develop the 'HELITRAK' tracking receiver system. Unlike some of the proprietary counterparts, this is a set of equipment which facilitates automatic tracking when applied to an existing radio-link receiver. It is specially tailored to the requirements of a video transmission system and needs only one conventionally transmitted radio-link signal. It has the potential to increase the reliability and the maximum range of helicopter links,

and to improve operational efficiency. The text covers the development of the tracking system, detailing the operational requirements and the design options. The system uses a novel method of tracking by detecting the direction of incoming RF signals, using higher-order mode synthesis in the antenna feed. Operational experience (from use in live outside broadcasts) and system limitations are noted, and areas for further improvements are identified. Author

N93-20585*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF DYNAMIC CHARACTERISTICS OF

EXTENSION-TWIST-COUPLED COMPOSITE TUBULAR SPARS

RENEE C. LAKE, AMIR P. IZADPANAH (Sterling Software, Palo Alto, CA.), and ROBERT M. BAUCOM Washington Feb. 1993 59 p Original contains color illustrations

(Contract DA PROJ. 1L1-62211-A-47-AB; RTOP 505-63-36-01)

(NASA-TP-3225; L-16950; ARL-TR-30; NAS 1.60:3225) Avail:

CASI HC A04/MF A01; 5 functional color pages

The results from a study aimed at improving the dynamic and aerodynamic characteristics of composite rotor blades through the use of extension-twist coupling are presented. A set of extension-twist-coupled composite spars was manufactured with four plies of graphite-epoxy cloth prepreg. These spars were noncircular in cross-section design and were therefore subject to warping deformations. Three different cross-sectional geometries were developed: D-shape, square, and flattened ellipse. Three spars of each type were fabricated to assess the degree of repeatability in the manufacturing process of extension-twist-coupled structures. Results from free-free vibration tests of the spars were compared with results from normal modes and frequency analyses of companion shell-finite-element models. Five global modes were identified within the frequency range from 0 to 2000 Hz for each spar. The experimental results for only one D-shape spar could be determined, however, and agreed within 13.8 percent of the analytical results. Frequencies corresponding to the five global modes for the three square spars agreed within 9.5, 11.6, and 8.5 percent of the respective analytical results and for the three elliptical spars agreed within 4.9, 7.7, and 9.6 percent of the respective analytical results. Author

N93-20618# University Coll. of Swansea (Wales).

ADAPTIVITY-FLUIDS-LOCALIZATION. THE CHALLENGE TO COMPUTATIONAL MECHANICS

O. C. ZIENKIEWICZ In Manitoba Univ., Proceedings of the Thirteenth Canadian Congress of Applied Mechanics p 46-53 May 1991

Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

Three areas in computational mechanics which have practical importance are discussed and are shown to be to some extent interdependent. These areas are as follows: (1) adaptive, automatic refinement which permits error control of the approximation inherent in all discretized solutions; (2) satisfactory approximation to convection dominated problems of fluid mechanics, where the optimality of Galerkin type approximation does not necessarily exist; and (3) the numerical treatment of discontinuities (or localization) such as occur in many problems of solid mechanics with softening behavior and compressible fluids where shock formation develops. Here the continuous finite element approximation introduces obvious difficulties. In particular, the adaptive procedures of general applicability have a substantial role to play in both fluid mechanics and the localization occurring in both fluids and solids. This interaction may result in rapid progress in the whole spectrum of problems covered as research information becomes transferred from one area to another. Author (CISTI)

N93-20662# Windsor Univ. (Ontario). Dept. of Mechanical Engineering.

RESONANT RESPONSE ANALYSIS OF A HIGH SPEED GEAR

JEAN LEE In Manitoba Univ., Proceedings of the Thirteenth

Canadian Congress of Applied Mechanics p 268-269 May 1991 Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

The resonant response of high-speed, lightweight and highly loaded gears may cause rapid and destructive failure. The resonant response of a transmission gear in a jet engine experiencing resonant failure was investigated. It is a 97-tooth planet gear in a planetary gear train. Its operating range is from 7800 to 10,000 rpm. The finite element method was used to evaluate the resonance behavior of the gear. Experimental work was subsequently conducted to confirm the mode shapes and the level of response. A resonance analysis was also carried out to identify the resonant frequencies when the gear is rotating. It was found that the finite element method accurately predicted the natural frequencies of the complex gear shape. The results of this work were used to modify the gear design so that its natural frequencies do not coincide with any operational excitation condition. Author (CISTI)

N93-20666# Laval Univ. (Quebec). Dept. of Mechanical Engineering.

DYNAMIC SIMULATION OF FLEXIBLE BODY SYSTEMS BY THE VECTOR SOLUTION METHOD [SIMULATION DYNAMIQUE DES SYSTEMES DE CORPS FLEXIBLES PAR LA METHODE DU RESEAU VECTORIEL]

TENNICH MOHAMED and MARC J. RICHARD In Manitoba Univ., Proceedings of the Thirteenth Canadian Congress of Applied Mechanics p 276-277 May 1991 In FRENCH

Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

In the present work an analysis of vibration of a flexible beam with a continuous distribution of mass and rigidity was undertaken. This study was limited to uni directionally flexible bodies, such as straight beams with uniform or variable sections, and is based on the Bernoulli equations for transverse vibration of beams without structural damping. The solution to the Bernoulli equation is formulated by a product of a deflection term, $X(x)$ and a temporal term $T(t)$ given by the Duhamel integral. The dynamics of a solid in three dimensional space is represented by the Euler equations. A mathematical model based on the vector network method is presented. A study of the effect of landing impact and of roughness of the landing strip on vibrations in the wings of aircraft was undertaken using the model. For large aircraft the dynamic loads induced by landing impact are important factors in fatigue damage to the aircraft. This study demonstrated the potential for vector network methods in the simulation of the dynamics and vibration of mechanical systems composed of rigid and flexible members. The study showed the presence of large induced vibrations in the wings as a result of landing impact and of the surface roughness of the landing strip. Author (CISTI)

N93-20689# Toronto Univ. (Ontario). Dept. of Mechanical Engineering.

AN EXPERIMENTAL INVESTIGATION OF A ROUND TURBULENT JET IN A CROSS-FLOW

Z. HUANG, J. G. KAWALL, and J. F. KEFFER In Manitoba Univ., Proceedings of the Thirteenth Canadian Congress of Applied Mechanics p 492-493 May 1991

Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

The behavior of a round turbulent jet in a cross flow is of considerable importance to the operation of very short takeoff and landing (VSTOL) aircraft. An experimental investigation of the turbulent jet flow that results when a circular jet is injected perpendicularly from an elevated source into a uniform, steady cross source is described. Mean and root mean square velocity isocontours of the vertical center plane depicted the spread of the isothermal jet and its interaction with the cross flow and the wake behind the stack. Interactions below the center line of the jet involving the jet wake and the stack wake was wide and diffuse in comparison with the interaction region above the jet center line. Mean velocity isocontours provided the characteristics of the overall spread of a jet in a cross wind. Mean temperature isocontours for a heated jet in a cross wind provided a clear

picture of the average shape of the jet since temperature acts as a tracer. A comparison of the isothermal contour plots obtained at various downstream locations establishes that the cross sectional shape of the jet evolves from a kidney shape in the near field to a roughly round shape in the far field. Autospectra of the temperature signals reveal that, in the lower region, a distinct frequency centered activity exists, there being a marked peak in the auto spectrum at a frequency of about 50 Hz. By contrast, no such activity exists in the upper region. Author (CISTI)

N93-20696# Concordia Univ., Montreal (Quebec). Dept. of Mechanical Engineering.

STOCHASTIC FINITE ELEMENT ANALYSIS FOR HIGH SPEED ROTORS

T. S. SANKAR, S. ANANTHA RAMU (Indian Inst. of Science, Bangalore.), and R. GANESAN /n Manitoba Univ., Proceedings of the Thirteenth Canadian Congress of Applied Mechanics p 610-611 May 1991

Copyright Avail: University of Manitoba, Winnipeg, MB R3T 2N2, Canada

A general finite element method is developed for the dynamic analysis of complex rotor systems in which several of the system parameters are stochastic quantities. The stochastic characteristics of the free and forced vibration response are derived in terms of the stochastic material property characteristics. An equation is developed in which the variations of the modulus of elasticity and the mass density along the length of the shaft are represented as small fluctuations about their mean values and in terms of two independent, one dimensional, univariate real stochastic fields which are homogeneous with zero mean values. These are described through their variances and autocorrelation function. The Lagrangian equations of motion for the element when the system is rotating at a constant velocity are derived. The equation of motion of free vibration are reduced to the eigenvalue problem. Each stochastic process is characterized by three parameters: the mean, standard deviation, and scale of fluctuation so that the second order properties can be adequately extracted. The local average of any stochastic process and the cross covariances between any two stiffness coefficients or any two mass coefficients can be derived. The stochastic properties of the solution of the eigenvalue problem are determined by the perturbation method.

Author (CISTI)

N93-20765 Department of the Navy, Washington, DC.
HIGH EFFICIENCY, LOW WEIGHT AND VOLUME ENERGY ABSORBENT SEAM Patent

JAMES A. BUCKLEY, inventor (to Navy) and ELSA J. HENNINGS, inventor (to Navy) 23 Jun. 1992 7 p Filed 9 Sep. 1991 (AD-D015531; US-PATENT-5,123,616; US-PATENT-APPL-SN-758919) Avail: US Patent and Trademark Office

A parachute canopy seam joint for fastening a ribbon seam and a radial seam of a parachute canopy together is presented. This parachute canopy seam joint combines a ribbon seam using a zigzag stitch pattern and narrow strips of radial tape sewn together with multiple rows of a straight stitch pattern. The ribbon seam attaches two overlapping ribbons within the parachute. The narrow strips of radial tape shroud the ribbon seam which result in a high strength and low weight and volume radial seam and seam joint. This new configuration of a parachute seam joint has distinct advantages in terms of strength and shock absorbing capacity. Specifically, this new parachute seam joint has a seam strength equal to or greater than the minimum rated strength of the ad-joining materials and employs a smaller weight and volume of material than conventional radial seams and seam joints.

GRA

N93-20772 Department of the Navy, Washington, DC.

APPARATUS FOR REDUCTION OF VIBRATION IN LIQUID-INJECTED GAS COMPRESSOR SYSTEM Patent

HARRY J. SKRUCH, inventor (to Navy) and JOHN R. WARD, inventor (to Navy) 22 Sep. 1992 6 p Filed 17 Jun. 1991

(AD-D015607; US-PATENT-APPL-SN-718322) Avail: US Patent and Trademark Office

An apparatus for reducing high vibration and pulsation levels generated by the discharge of gas-liquid mixtures from compressors is presented. A tuyere is positioned within the compressor housing to separate the gas from the liquid. GRA

N93-20790 Department of the Navy, Washington, DC.

SINGLE SCREW INTERRUPTED THREAD POSITIVE DISPLACEMENT MECHANISM Patent

WAYNE W. BOBLITT, inventor (to Navy) 14 Jul. 1992 9 p Filed 17 Jul. 1991

(AD-D015596; US-PATENT-5,129,800;

US-PATENT-APPL-SN-731233) Avail: US Patent and Trademark Office

A single screw positive displacement compressor mechanism employing shallow gate rotor tooth penetration of the main rotor for purposes of reducing internal leakage and consequent compressor inefficiencies is presented. The invention is provided with an interrupted main rotor thread for purposes of insuring multiple gate rotor teeth meshing with the drive portion of the main rotor thread, thereby reducing gate rotor tooth flank loads in the compressor section of the device. Provision is also made for main rotor thread baffling between the main rotor chamber section and the mechanism inlet. GRA

N93-20907# Alenia Spazio S.p.A., Rome (Italy). Direzione Tecnica Trasporto.

MSC/NASTRAN STRUCTURE OPTIMIZATION TEST MODULE VERSION 67 (PRELIMINARY) [TEST MODULO OTTIMIZZAZIONE STRUTTURE MSC/NASTRAN VERSIONE 67 (PRELIMINARE)]

G. ATTANASIO 23 Sep. 1991 86 p In ITALIAN

(REPT-5-191025; ETN-93-92886) Avail: CASI HC A05/MF A01

An evaluation of the structural optimization module Solution 200 of the MSC/NASTRAN version 67 (preliminary) is presented. As well as ascertaining the level of the solutions for which tests could not previously be carried out because of existing code errors, the aim is to verify if such errors are effectively corrected and if eventual changes or implementations are carried out on the optimization module. The following tests are reported: three bar truss, ten bar truss, twenty five bar truss, sixty three bar truss, two bar truss, two shear truss, two squad truss, wing torsion box, cantilever beam, and elements of the Airbus A321. A description of the model and the type of optimization problem to be solved is given for each case. ESA

N93-21254# United Technologies Corp., East Hartford, CT.

ADVANCED TURBINE DESIGN FOR COAL-FUELED ENGINES

N. S. BORNSTEIN 17 Jul. 1992 29 p

(Contract DE-AC21-89MC-26052)

(DE93-000224; DOE/MC-26052/3140) Avail: CASI HC A03/MF A01

The objective of this task is to perform a technical assessment of turbine blading for advanced second generation PFBC conditions, identify specific problems/issues, and recommend an approach for solving any problems identified. A literature search was conducted, problems associated with hot corrosion defined and limited experiments performed. Sulfidation corrosion occurs in industrial, marine and aircraft gas turbine engines and is due to the presence of condensed alkali (sodium) sulfates. The principle source of the alkali in industrial, marine and aircraft gas turbine engines is sea salt crystals. The principle source of the sulfur is not the liquid fuels, but the same ocean born crystals. Moreover deposition of the corrosive salt occurs primarily by a non-equilibrium process. Sodium will be present in the cleaned combusted gases that enter the PFBC turbine. Although equilibrium condensation is not favored, deposition via impaction is probable. Marine gas turbines operate in sodium chloride rich environments without experiencing the accelerated attack noted in coal fired boilers where condensed chlorides contact metallic surfaces. The sulfates of calcium and magnesium are the products of the reactions used to control sulfur. Based upon industrial gas turbine experience

and laboratory tests, calcium and magnesium sulfates are, at temperatures up to 1500 F (815 C), relatively innocuous salts. In this study it is found that at 1650 F (900 C) and above, calcium sulfate becomes an aggressive corrodent. DOE

N93-21322# Ecole Nationale Supérieure de Mécanique et d'Aérotechnique, Poitiers (France). Lab. de Mécanique et de Physique des Matériaux.

DAMAGE TOLERANCE OF A HELICOPTER ROTOR HIGH-STRENGTH STEEL

GILBERT HENAFF, JEAN PETIT, and NARAYAMASWAMI RANGANATHAN / In Technical Research Centre of Finland, Fatigue Design 1992; Volume 1 p 73-87 1992 Sponsored by Aerospatiale, Suresnes, France
Copyright Avail: CASI HC A03/MF A03

The fatigue crack growth behavior of a high strength steel is investigated in air and in vacuum under loading representative of helicopter spectra. The near threshold regime is considered with a high baseline level ($R = 0.7$). Although strong interaction effects are brought out, non concomitant closure is detected due to the high mean level of the different loading blocks. A model of the observed retardation phenomenon, which incorporates crack growth laws previously developed to describe the influence of environment, is proposed. The results are in good agreement with experimental data. ESA

N93-21382# Queensland Univ., Brisbane (Australia). Dept. of Civil Engineering.

EXPERIMENTS ON SMOOTH CANTILEVERED CIRCULAR CYLINDERS IN A LOW-TURBULENCE UNIFORM FLOW. PART 2: FLUCTUATING LOADS ON A CANTILEVER OF ASPECT RATIO 30

T. A. FOX and G. S. WEST Nov. 1991 49 p
(PB93-110500; RR-CE131; ISBN-0-86776-464-3) Avail: CASI HC A03/MF A01

Part 2 of this report presents details of an investigation into the fluctuating loads induced on a smooth, cantilevered circular cylinder with an aspect ratio of 30 immersed in a low-turbulence uniform flow. Experiments were carried out in a wind tunnel at Reynolds numbers of 4.4×10^4 (exp 4) and 6.6×10^4 (exp 4) and involved the measurement of fluctuating pressures and forces. Oil-flow visualization was performed to determine the flow pattern at the surface of the cylinder. The results reveal the nature of the disturbance induced by the flow around the free-end of a cantilever and the full extent of the spanwise variation of fluctuating pressures and forces. GRA

N93-21383# Queensland Univ., Brisbane (Australia). Dept. of Civil Engineering.

EXPERIMENTS ON SMOOTH CANTILEVERED CIRCULAR CYLINDERS IN LOW-TURBULENCE UNIFORM FLOW. PART 1: MEAN LOADING WITH ASPECT RATIOS IN THE RANGE 4 TO 30

T. A. FOX and G. S. WEST Nov. 1991 85 p
(PB93-111763; RR-CE130; ISBN-0-86776-461-9) Avail: CASI HC A05/MF A01

Part 1 of the report presents details of an investigation into the mean loading of smooth, cantilevered circular cylinders immersed in a low-turbulence uniform flow. Experiments were performed in a wind tunnel at a Reynolds number of 4.4×10^4 (exp 4) for aspect ratios in the range 4 to 30. Mean surface pressures and vortex shedding frequencies were measured, from which the local mean pressure drag and Strouhal number were calculated at various spanwise locations. The results reveal the extent of the disturbance induced by the flow around the free-end of a cantilever and the existence of a significant aspect ratio of 13. GRA

N93-21465# American Gas Association Labs., Cleveland, OH.
ENGINE DRIVEN CHILLER AND THERMAL STORAGE INTEGRATION (LARGE TONNAGE ENGINE DRIVEN CHILLER DEVELOPMENT) Final Report, Sep. 1988 - Jun. 1991

L. ERICKSEN Nov. 1991 135 p

(Contract GRI-5088-293-1716)

(PB92-227891; GRI-91/0258) Avail: CASI HC A07/MF A02

The cost of electricity when air conditioning is a prominent demand load for the utility is rapidly increasing. This increased cost has attracted building owners and engineers to demand reduction strategies. Engine chillers and thermal storage are demand reduction products for commercial cooling needs. The combination of these products into one commercially attractive product is the goal of this project. An economic assessment and a lab testing program were completed. These efforts have produced field design equations, performance information, and a generic control scheme. Clear understanding of the competitive advantages of engine chiller/thermal storage over various electric thermal storage options for the customer has been achieved. Cost targets for engine chillers and for thermal storage to match the capital cost of the lowest cost electric thermal storage option have been defined. GRA

N93-21529# Hellenic Aerospace Industry, Schimatari (Greece). Advanced Materials, Processes and Manufacturing Lab.

DAMAGE DETECTION BY ACOUSTO-ULTRASONIC LOCATION (AUL)

Z. P. MARIOLI-RIGA, A. N. KARANIKA, T. P. PHILIPPIDIS (Patras Univ., Greece.), and S. A. PAIPETIS (Patras Univ., Greece.) / In AGARD, Debonding/Delamination of Composites 3 p Dec. 1992

Copyright Avail: CASI HC A01/MF A03

Damage detection in aircraft structures in-situ is important, especially with not visible defects in composite components for a variety of reasons. In the present paper a new technique based on the Acousto-Ultrasonic (AU) concept is introduced, but instead of extracting information from the externally generated pulsed wave, as with AU, the characteristics of waves reflected from defects are measured. In this way it was possible to identify and locate defected areas in honeycomb panels and thermoplastic carbon fiber laminates. The results were correlated with ultrasonic C-scans, and satisfactory agreement was obtained. The present is part of a major project aiming at the development of a fast inspection method for aircraft components during routine maintenance cycles. Author

N93-21819*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

CROSSFLOW STABILITY AND TRANSITION EXPERIMENTS IN A SWEEPED-WING FLOW Ph.D. Thesis

JOHN RAY DAGENHART Dec. 1992 286 p Sponsored by NASA. Langley Research Center
(NASA-TM-108650; NAS 1.15:108650) Avail: CASI HC A13/MF A03

An experimental examination of crossflow instability and transition on a 45 degree swept wing is conducted in the Arizona State University Unsteady Wind Tunnel. The stationary-vortex pattern and transition location are visualized using both sublimating-chemical and liquid-crystal coatings. Extensive hot-wire measurements are conducted at several measurement stations across a single vortex track. The mean and travelling-wave disturbances are measured simultaneously. Stationary-crossflow disturbance profiles are determined by subtracting either a reference or a span-averaged velocity profile from the mean-velocity data. Mean, stationary-crossflow, and travelling-wave velocity data are presented as local boundary-layer profiles and as contour plots across a single stationary-crossflow vortex track. Disturbance-mode profiles and growth rates are determined. The experimental data are compared to predictions from linear stability theory. Author

N93-21831*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

APPLICATION OF ARTIFICIAL NEURAL NETWORKS TO THE DESIGN OPTIMIZATION OF AEROSPACE STRUCTURAL COMPONENTS

LASZLO BERKE, SURYA N. PATNAIK (Ohio Aerospace Inst.,

Brook Park.), and PAPPU L. N. MURTHY Mar. 1993 13 p
(Contract RTOP 505-63-5B)
(NASA-TM-4389; E-6994-1; NAS 1.15:4389) Avail: CASI HC
A03/MF A01

The application of artificial neural networks to capture structural design expertise is demonstrated. The principal advantage of a trained neural network is that it requires trivial computational effort to produce an acceptable new design. For the class of problems addressed, the development of a conventional expert system would be extremely difficult. In the present effort, a structural optimization code with multiple nonlinear programming algorithms and an artificial neural network code NETS were used. A set of optimum designs for a ring and two aircraft wings for static and dynamic constraints were generated by using the optimization codes. The optimum design data were processed to obtain input and output pairs, which were used to develop a trained artificial neural network with the code NETS. Optimum designs for new design conditions were predicted by using the trained network. Neural net prediction of optimum designs was found to be satisfactory for most of the output design parameters. However, results from the present study indicate that caution must be exercised to ensure that all design variables are within selected error bounds. Author

N93-22005* United Technologies Corp., East Hartford, CT.
STRUCTURAL TAILORING OF ADVANCED TURBOPROPS (STAT). THEORETICAL MANUAL
K. W. BROWN Oct. 1992 79 p
(Contract NAS3-23941)
(NASA-CR-191017; NAS 1.26:191017; PWA-5767-109) Avail:
CASI HC A05/MF A01

This manual describes the theories in the Structural Tailoring of Advanced Turboprops (STAT) computer program, which was developed to perform numerical optimizations on highly swept propfan blades. The optimization procedure seeks to minimize an objective function, defined as either direct operating cost or aeroelastic differences between a blade and its scaled model, by tuning internal and external geometry variables that must satisfy realistic blade design constraints. The STAT analyses include an aerodynamic efficiency evaluation, a finite element stress and vibration analysis, an acoustic analysis, a flutter analysis, and a once-per-revolution (1-p) forced response life prediction capability. The STAT constraints include blade stresses, blade resonances, flutter, tip displacements, and a 1-P forced response life fraction. The STAT variables include all blade internal and external geometry parameters needed to define a composite material blade. The STAT objective function is dependent upon a blade baseline definition which the user supplies to describe a current blade design for cost optimization or for the tailoring of an aeroelastic scale model. Author

N93-22035* National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.
METHOD AND APPARATUS FOR CLEANING RUBBER DEPOSITS FROM AIRPORT RUNWAYS AND ROADWAYS
Patent
SANDY M. STUBBS, inventor (to NASA) 6 Apr. 1993 5 p
Filed 3 Apr. 1991 Supersedes N91-28455 (29 - 20, p 3332)
(NASA-CASE-LAR-14483-1; US-PATENT-5,199,128;
US-PATENT-APPL-SN-682153; US-PATENT-CLASS-15-52;
US-PATENT-CLASS-15-80; US-PATENT-CLASS-15-87;
INT-PATENT-CLASS-A47L-11/282) Avail: US Patent and
Trademark Office

A method and apparatus for cleaning rubber deposits from surfaces such as airport runways and roadways is disclosed. The apparatus includes a large vehicle that has the capacity to be loaded so as to effectively add weight to the rubber cleaning tires of the vehicle. In addition, the vehicle has a water tank and sprinkler system so that the surface may be wetted down in front of the tires as the vehicle proceeds across the surface. The cleaning tires of the apparatus are aligned so that they are at a yaw angle to the direction of travel, and the cleaning tire assembly is attached to the underside of the trailer of the vehicle and positioned between a forward and rear water tank. In addition, this tire assembly is

equipped with a means of loading the tires onto the contaminated surface. The method comprises driving such a vehicle at low speeds down the surface as the road is being wet in front of the cleaning tires. The effect of the angled tires is to create a scrubbing action that not only heats the rubber deposits by friction but also causes it to be removed from the surface. The rubber that does not stick to the cleaning tires is then removed from the surface by sweeping.

Official Gazette of the U.S. Patent and Trademark Office

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A93-24173**NEW CONCEPTS IN REMOTE SENSING AND GEOLOCATION**

A. J. SEASTONE (Energetics Satellite Corp., Englewood, CO) /n Small-satellite technology and applications; Proceedings of the Meeting, Orlando, FL, Apr. 4, 5, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 228-239. Copyright

The SAT/TRAC technology, which provides a new concept in geolocation and remote sensing products and services, is described. The approach to location determination and remote-sensing data collection described here uses a satellite configuration that supports a unique antenna payload designed to scan the earth's surface to receive location and messaging data from inexpensive end-user transceivers and relay this information to ground centers for processing and distribution. L.M.

A93-24213**REMOTE SENSING OF VOLCANIC ASH HAZARDS TO AIRCRAFT**

WILLIAM I. ROSE and DAVID J. SCHNEIDER (Michigan Technological Univ., Houghton) /n Earth and atmospheric remote sensing; Proceedings of the Meeting, Orlando, FL, Apr. 2-4, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 387-390. refs
(Contract NSF EAR-89-16323)
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Detailed examinations have been made of the multispectral imagery of eruptions from Augustine Volcano and Redoubt Volcano in Alaska collected by the AVHRR aboard polar orbiting NOAA weather satellites. The present data set, which contains more than 70 images of eruptions from the two volcanoes, offers an elaborate test of the utility of synoptic weather satellites for discriminating and tracking eruption clouds. Ashes collected from the field are also used in a laboratory spectral study to gain a better understanding of different spectral characteristics of ash clouds as detected by the AVHRR. V.L.

A93-24391**MEASUREMENTS OF JET AIRCRAFT EMISSIONS AT CRUISE ALTITUDE. I - THE ODD-NITROGEN GASES NO, NO₂, HNO₂ AND HNO₃**

F. ARNOLD, J. SCHEID, TH. STILP (Max-Planck-Inst. fuer Kernphysik, Heidelberg, Germany), H. SCHLAGER, and M. E. REINHARDT (DLR, Inst. fuer Physik der Atmosphaere, Oberpfaffenhofen, Germany) Geophysical Research Letters (ISSN 0094-8276) vol. 19, no. 24 Dec. 24, 1992 p. 2421-2424. Research supported by DLR refs
Copyright

Using a novel aircraft-borne automatic mass spectrometer, the odd-nitrogen gases NO, NO₂, HNO₂, and HNO₃ were measured in a young exhaust-trail of a jetliner at cruise-altitude. The measurements, which took place at an altitude of 9.5 km and a

distance of about 2 km from a DC-9 jetliner, revealed NO and NO₂ to be present with abundances as large as 780 and 150 ppbv, respectively. The acids HNO₂ and HNO₃ reached abundances of 0.52 and 0.46 ppbV, which implies that only about 0.05 percent of the emitted reactive nitrogen experienced rapid conversion to the stable odd nitrogen reservoir nitric acid. Hence, most of the emitted odd-nitrogen remained in the reactive form NO and NO₂, which affect ozone. The low HNO₃-emission implies that HNO₃-H₂O nucleation and condensation in jet-aircraft plumes is hardly favored by the additional HNO₃. However, it may still occur due to H₂O emissions. Author

A93-24566
CRACK MODELS FOR A TRANSVERSELY ISOTROPIC MEDIUM

C. H. CHENG (MIT, Cambridge, MA) *Journal of Geophysical Research* (ISSN 0148-0227) vol. 98, no. B1 Jan. 10, 1993 p. 675-684. Research supported by Borehole Acoustics and Logging Consortium refs (Contract DE-FG02-86ER-13636) Copyright

The results of Hudson's (1980, 1981) model for a transversely isotropic cracked rock are compared with those of Anderson et al. (1974) and Cheng (1978), using the long-wavelength static approximation and the ellipsoidal crack model of Eshelby (1957). It is shown that the 'weak material' version of Hudson's (1981) model and the models based on the complete Eshelby theory agree for small-aspect-ratio cracks and small crack densities. For larger crack densities but small aspect ratios, only Hudson's first-order term agrees with the Eshelby solution; no general statement can be made on the accuracy of the second-order expansion that is valid for different situations. A new expansion is proposed, based on the Pade approximation, which is identical to Hudson's expansion up to second-order in density. I.S.

A93-24914#
ATMOSPHERIC TURBULENCE ALOFT - A REVIEW OF POSSIBLE METHODS FOR DETECTION, WARNING, AND VALIDATION OF PREDICTION MODELS

A. J. BEDARD, JR. (NOAA, Wave Propagation Lab., Boulder, CO) Jan. 1993 20 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0847) Copyright

The use of pilot reports has been a valuable resource for verifying predictions of clear air turbulence (CAT) aloft and providing guidance for following pilots. Also, past investigations have indicated the value of the Richardson number as an index of CAT. Microbarograph arrays have detected pressure fluctuations related to gravity waves, levels of low Richardson number, and pilot reports of turbulence. Moreover, source regions of infrasound have also been correlated with locations of aircraft reports of turbulence. More recently, the NOAA wind profiler network offers opportunities for monitoring turbulence above the profiler sites, which are ideal for combined studies using arrays of microbarographs as well as other enhancements. In addition, a new passive infrasonic detection system with improved processing has shown potential for detecting regions of turbulence in the vicinity of mountains. This paper reviews the range of possibilities available for improving CAT detection, warning, and model validation. Author

A93-24916#
INFRARED DETECTION OF HIGH ALTITUDE CLEAR AIR TURBULENCE

PETER C. SINCLAIR (Colorado State Univ., Fort Collins) and PETER M. KUHN (Atmospheric Research and Instrumentation Systems, Inc., Fort Collins, CO) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (Contract N62271-90-M-3421) (AIAA PAPER 93-0852) Copyright

A technique is described which makes it possible to remotely detect threats of clear air turbulence (CAT) in the lower stratosphere

for unmanned airborne vehicles designed for high-altitude long-endurance (HALE) aircraft operations and employing long, high-aspect-ratio laminar flow wings. A forward-looking infrared system was designed which can detect the CAT hazard far enough ahead of the HALE aircraft, using an 'S' layer model which relates the vertical temperature structure to the location and intensity of CAT. Analytical results showed that, in all the CAT cases studied, the scanning signal difference (or detectable IR return) was well within the Noise Equivalent Radiance of the proposed radiometric system. I.S.

A93-26005
NICKEL HYDROGEN BATTERIES FOR TERRESTRIAL APPLICATIONS

JEFFREY P. ZAGRODNIK and KENNETH R. JONES (Johnson Controls Battery Group, Inc., Butler, WI) *In* IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 3 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 3.81-3.86. Research supported by DOE refs Copyright

Common pressure vessel (CPV) design configurations of Ni-H₂ batteries for load leveling, remote energy storage, and aircraft starting are discussed. A nominal 7 kWh photovoltaic energy storage battery is being tested at Johnson Controls and has completed over 800 cycles to date. It delivers about 10 kWh and demonstrates steady performance over a wide range of charge and discharge rates (C/3 to C/20). A pair of 2 kWh photovoltaic batteries are being tested at the Florida Solar Energy Center for lighting, vaccine refrigeration, and repeater station. A 20-volt, 55 amp-hour CPV aircraft starting battery is being tested at the Wright Patterson Air Force Base. This battery is characterized by high reliability, no maintenance, and direct state-of-charge monitoring from battery pressure, which makes it an excellent candidate for this application. O.G.

A93-28476
INTER-NOISE '91; PROCEEDINGS OF THE 20TH INTERNATIONAL CONFERENCE ON NOISE CONTROL ENGINEERING, SYDNEY, AUSTRALIA, DEC. 2-4, 1991. VOLS. 1 & 2

ANITA LAWRENCE, ED. (New South Wales Univ., Kensington, Australia) Poughkeepsie, NY Noise Control Foundation 1991 p. Vol. 1, 772 p.; vol. 2, 552 p. (ISBN 0-909882-12-6) Copyright

The present volume on the cost of noise discusses air conditioning noise, noise control in the aluminum industry, international standards for the determination of sound power levels, and advances in adaptive signal processing as applied to the active control of sound and vibration. Attention is given to aircraft noise, hearing and hearing conservation, sound transmission through structures, and noise sources. Topics addressed include physical phenomena of sound, noise control elements, vibration and shock generation, and transmission, isolation, and reduction. Also discussed are noise reduction programs for in-service jet transports, the influence of aircraft noise on speech intelligibility, noise control of compressors in power stations, and sound exposure spectrum levels of sonic booms. (For individual items see A93-28477 to A93-28498) C.A.B.

A93-28477
LOUDNESS VERSUS LEVEL OF AIRCRAFT NOISE

HUGO FASTL (Muenchen, Technische Univ., Munich, Germany) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 33-36. refs (Contract DFG-SFB-204) Copyright

Some scenarios of loudness differences expected with phasing out stage 2 aircraft are discussed. Although the data are given only for one pair of loud vs softer aircraft, the trends are argued to be very typical. A simple rule of thumb (10 dB less means half

the loudness) relating to perceived loudness and measured levels can be rather misleading. In some cases, the perceived loudness ratios are smaller; in other cases they are greater than predicted. Therefore, forecasts of variations in the 'noise climate' around airports that are based solely on L_{eq} values can be somewhat dangerous. By contrast, subjective noise evaluations can be successfully predicted by physical loudness measurements.

C.A.B.

A93-28478**CONTINUOUS JUDGMENT OF HELICOPTER NOISE - ON THE VALIDITY OF L_{eq} AND ZWICKER'S METHOD (ISO 532B)**

SONOKO KUWANO and SEIICHIRO NAMBA (Osaka Univ., Toyonaka, Japan) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 37-40. refs
Copyright

The method of continuous judgment by category is used to examine instantaneous impressions of helicopter noise, and the semantic differential is used to investigate overall impression. The validity of L_{eq} and Zwicker's loudness level (LL_z) based on ISO 532B is studied as a measure of helicopter noise. LL_z is found to exhibit higher correlation with subjective impressions and wider applicability than L_{eq} . With regard to timbre of helicopter noise, an evaluation by LL_z or L_{eq} may not be sufficient.

C.A.B.

A93-28483**INFLUENCE OF AIRCRAFT NOISE ON SPEECH INTELLIGIBILITY**

TRULS GJESTLAND, IDAR L. N. GRANOIEN, and KARE H. LIASJO (Norwegian Inst. of Technology, Trondheim, Norway) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 199-202. refs
Copyright

A new set of noise criteria aimed at characterizing the noise situation in the vicinity of an airport with respect to verbal communication has been developed. The INM 3 TA procedure, combined with the Articulation Index, can be used to assess the noise situation around an airport with respect to the possibility of undisturbed speech communication. If the acceptable limits for interruption are quantified as the number of minutes per hour, the INM 3 program can be used to determine which areas fulfill the requirements depending on the total traffic.

C.A.B.

A93-28484**PRELIMINARY RESULTS FROM A STUDY OF COMMUNITY RESPONSE TO NOISE FROM MILITARY AIRCRAFT EXERCISE**

JENS-JORGEN BUGGE (Norwegian Defence Construction Service, Oslo, Norway), TRULS GJESTLAND, KARE LIASJO, and IDAR GRANOIEN (Norwegian Inst. of Technology, Trondheim, Norway) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 203-206.
Copyright

Reactions to aircraft noise, changes in behavior, and differences in attitude as a function of noise exposure are discussed. A survey was conducted in Norway to assess the relative influence of a short-term increase in airport activity. The noise level and subjective response over a period of 50 weeks are illustrated.

C.A.B.

A93-28485**NIGHT AIRCRAFT NOISE INDEX AND SLEEP RESEARCH RESULTS**

MICHEL VALLET and ISABELLE VERNET (INRETS LEN, Bron, France) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 207-210. refs
Copyright

Consideration is given to how results of research on the effects of noise and the duration and quality of sleep of people living around airports can be used in proposing noise criteria pertaining to the preservation of a certain quality of sleep. It is found that the tolerance to noise with regard to sleep pass through a maximum value for an optimum number of 10 to 15 flights per night. The peak noise measured within dwellings should not exceed 48 dB(A).

C.A.B.

A93-28486**FINAL RESULTS FROM A STUDY OF COMMUNITY RESPONSE TO AIRCRAFT NOISE AROUND OSLO AIRPORT FORNEBU**

TRULS GJESTLAND, IDAR L. N. GRANOIEN, and KARE H. LIASJO (Norwegian Inst. of Technology, Trondheim, Norway) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 211-214. Research supported by Norwegian Civil Aviation Administration
Copyright

Results of noise measurements and a social survey conducted in the vicinity of Oslo Airport Fornebu are presented. Subjective responses to a number of factors concerning activity interference, behavioral reactions, and health were studied as a function of noise exposure levels. For noise levels above 45 EFN, there is roughly a linear relationship with noise level for activity interference, behavioral reactions, and all but two complaint actions. More people reported speech interference than any other activity interference, and the rates of speech interference increase more rapidly with increasing noise level than does any other reaction. At roughly 65 EFN aircraft noise was spontaneously mentioned as a local problem by half the exposed population.

C.A.B.

A93-28493**THE COSTS OF NOISE AT THE NEW MUNICH AIRPORT**

WOLFGANG HERZING *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 2 Poughkeepsie, NY Noise Control Foundation 1991 p. 773-776.
Copyright

The legal and financial aspects of reducing noise at the new Munich airport are discussed. Attention is given to sound insulation of buildings, compensation for deterioration in the value of real estate, a hangar for engine tests, and a noise monitoring system. The Munich Airport Authority is expected to spend more than DM 180 million to ease and control the noise emissions in its vicinity.

C.A.B.

A93-28495**FATIGUE EFFECTS OF NOISE AMONG AIRPLANE MECHANICS**

ANDERS KJELLBERG, BJORN SKOLDSTROM (National Inst. of Occupational Health, Solna, Sweden), PER ANDERSSON (Swedish Foundation for Occupational Health and Safety for State Employees, Angelholm, Sweden), and LENNART LINDBERG (National Inst. of Occupational Health, Umea, Sweden) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 2 Poughkeepsie, NY Noise Control Foundation 1991 p. 883-886. refs
Copyright

The fatigue effects of noise among airplane mechanics were studied in Sweden during a week with high exposure (runway work) and a week with low exposure (repair work). A simple reaction time (RT) task was used. In addition to RT performance, the mechanics rated their fatigue using a mood adjective check list. The fatigue effects were studied by having the subjects rate their mood before and after work each day of the work week. The results confirmed the hypothesis that mechanics felt more sleepy and less energetic after a week of work on the runway than after repair work. Mood ratings showed that this effect was most evident towards the end of the day and that there was a gradual build-up

of the effect during the week. RTs were longer during the runway week. The RT effect did not differ significantly between the morning and afternoon sessions. The fact that the performance effect was evident already in the morning indicates an accumulated effect of four days on the runway. Noise exposure was argued to be the most likely cause of the fatigue. C.A.B.

A93-28496
NOISE-INDUCED REACTION IN A WORK COMMUNITY
ADJACENT TO AIRCRAFT RUNWAYS - THE ROYAL
AUSTRALIAN AIRFORCE

R. F. S. JOB (Sydney Univ., Australia), R. B. BULLEN (Renzo Tonin & Associates, Sydney, Australia), and D. H. BURGESS (National Acoustic Labs., Chatswood, Australia) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 2 Poughkeepsie, NY Noise Control Foundation 1991 p. 895-898. refs

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Results are presented of a study conducted at the RAAF bases at Williamstown and Richmond, Australia, to examine: the extent to which features of resident community reaction generalize to a community exposed to noise while at work; the most appropriate noise index for describing reaction to aircraft noise in the workplace; any impact of noise sensitivity, attitude, or demographic variables on reaction; and the relevance for land-use planning on airbases. Reaction to noise experienced at work is similar to reaction in residential communities, with the exception that reaction at work may be lower than for residents for the same level of noise exposure. Noise/reaction relationships are significantly influenced by whether or not the internal noise can be modified. C.A.B.

A93-28497
COMPUTER-BASED MODELLING OF AIRCRAFT NOISE
IMPACT

MALCOLM HUNT (Royds Garden, Ltd., Wellington, New Zealand) and EDWARD NYE (E.J. Nye & Associates Pty., Ltd., North Sydney, Australia) *In* Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 2 Poughkeepsie, NY Noise Control Foundation 1991 p. 927-930. refs

Copyright

A method of determining the distribution of economic indicators, such as house values and household income levels, in an area exposed to aircraft noise is described. The hypothesis that airport noise has a detectable economic impact, and that house valuation and property appraisal and household income levels are a measure of this is examined, and results are illustrated in tables and figures. C.A.B.

A93-28865
SHORT-TERM ATMOSPHERIC EFFECTS OF HIGH-ALTITUDE
AIRCRAFT EMISSIONS

M. IU. DANILIN, B. C. KRUEGER, and A. EBEL (Cologne Univ., Germany) *Annales Geophysicae* (ISSN 0992-7689) vol. 10, no. 11-12 Dec. 1992 p. 904-911. Research supported by DAAD refs

Copyright

The purpose of this work is to study the short-term response of the atmospheric trace gas composition to perturbations in the aircraft plume region. A one-dimensional model of the atmosphere is applied and two scenarios of aircraft emissions are considered. They correspond to perturbations from hypersonic aircraft with H₂ combustion engines in the stratosphere (mainly at 26 km) and from modern aircraft at altitudes around 10 km. The following problems are investigated: the magnitude and temporal behavior of ozone response at different altitudes for different initial concentrations of NO(x) the role of eddy diffusion and of the heterogeneous reaction N₂O₅ + H₂O-2HNO₃, possible chemical transformations of NO(x) in the plume, and diurnal atmospheric effects of aircraft emissions. Author

A93-29660

CHOICE OF THE HEATING SYSTEM FOR
HIGH-TEMPERATURE GENERATORS USING CHEMICAL FUEL
[VYBOR SISTEMY NAGREVA DLIA
VYSOKOTEMPERATURNYKH GENERATOROV NA
KHIMICHESKOM TOPLIVE]

N. I. ARTAMONOV, V. E. IVANOV, and P. P. LAVROV *In* Problems in the development of flight-vehicle energy systems and their use in the national economy Moscow Izdatel'stvo MAI 1991 p. 64-71. In Russian. refs

Copyright

Methods of increasing the heat transfer efficiency of heating devices for autonomous generators using mixtures of a liquid hydrocarbon fuel (e.g., kerosene and diesel fuel) and air are examined. In particular, attention is given to the use of radiation burners in which combustion takes place in the capillaries of a porous nozzle located in close proximity to the heated surface. Such burners provide conversion efficiencies of 38-70 percent (the lower efficiencies correspond to higher temperatures); the burners also serve as flame stabilizers, making it possible to vary the fuel consumption over wide ranges. Experimental results obtained for radiation burners using a kerosene-air mixture are reported. V.L.

N93-21501# Foster-Miller Associates, Inc., Waltham, MA.
ANALYSIS OF AIRCRAFT NOISE LEVELS IN THE VICINITY
OF START-OF-TAKEOFF ROLL AT
BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT Final
Report, Nov. 1991 - May 1992

RICHARD D. HORONJEFF (Harris, Miller, Miller and Hanson, Inc., Lexington, MA.) May 1992 92 p

(Contract DTRS-57-89-00009)

(PB92-221605; DOT-VNTSC-FAA-92-5; DOT/FAA/EE-92/01)

Avail: CASI HC A05/MF A01

The sound level prediction accuracy of the Federal Aviation Administration's Integrated Noise Model (INM) is receiving closer scrutiny today than at its inception due to a shifting emphasis in the model's application. In addition to the traditional land use planning application, the INM is now used as resource arbiters for local and federally funded noise mitigation programs. The increased model scrutiny has led to a reinspection of modeling assumptions in the vicinity of start-of-takeoff roll and the subsequent need for a well documented empirical database. The study focused on the gathering of such a database. The completed database consists of measured sound exposure levels (SEL's) and maximum A-weighted sound levels at five sites in the hemicircle behind the aircraft at brake release and at distances of 2,000 to 4,000 ft from the brake release point. Independent variables include measurement site/runway geometry, aircraft type, engine type, aircraft gross weight, wind speed and direction, temperature, relative humidity, barometric pressure, aircraft ground roll distance versus time, and time to liftoff. The information is all contained in standard dBase 3 database files. Findings shown in the report include the effects on SEL of wind speed and direction, and the interaction effects of wind speed direction and measurement site location. Also discussed are comparisons of measured SEL's and the predicted values of INM Version 3.10. GRA

N93-21799# Federal Aviation Administration, Cambridge, MA.
PROCEEDINGS OF THE AIRCRAFT WAKE VORTICES
CONFERENCE, VOLUME 2 Final Report

J. N. HALLOCK, ed. Jun. 1992 579 p Conference held in Washington, DC, 29-31 Oct. 1991 Sponsored by FAA, Washington, DC, NOAA, Rockville, MD, NASA, and National Transportation Safety Board, Washington, DC Original contains color illustrations reproduced in black and white

(PB93-127728; DOT/VNTSC-FAA-92-7-VOL-2;

DOT/FAA/SD-92/1-VOL-2) Avail: CASI HC A25/MF A06

The volume contains the proceedings of the international conference of Aircraft Wake Vortices held at the Quality Hotel Capital Hill, Washington, DC, on 29-31 Oct. 1991. The contributed papers discuss technological advances in the knowledge of the phenomenon, its effect on aircraft and airport capacity, detection techniques, and vortex avoidance schemes. GRA

N93-22045# Sandia National Labs., Albuquerque, NM.
STRESS CALCULATION FOR THE SANDIA 34-METER WIND TURBINE USING THE LOCAL CIRCULATION METHOD AND TURBULENT WIND

B. MASSE and H. PASTOREL (Institut de Recherche de l'Hydro-Quebec, Varennes.) Nov. 1992 108 p
 (Contract DE-AC04-76DP-00789)
 (DE93-004480; SAND-91-7012) Avail: CASI HC A06/MF A02

Stress calculation for wind turbine blades is an important task for the manufacturers of wind turbines. A good prediction of stress level is required to tabulate the fatigue life of the rotor. Design of critical blade joints is based on such calculations. Aerodynamic loads and atmospheric turbulence were identified as important factors in estimating fatigue damage. A stress estimate procedure and its application to the Sandia/DOE 34-meter wind turbine are described. The procedure uses the computer code developed at IREQ (MCL) for aerodynamic load calculation including atmospheric turbulence. Aerodynamic loads are decomposed into modal components and applied to structures using the finite element program NASTRAN. Rotating modes are computed as a linear composition of stationary modes. The stress distributions as functions of frequency are extracted from the modal frequency response for critical locations on the blade. Stress distributions are calculated for the first five harmonics of the rotational speed and for off-harmonic frequencies. Calculated stress amplitude spectra are compared with Malcolm's results and with test data. The results indicate that improved aerodynamic loading is obtained from MCL and that aeroelastic effects needs to be added to obtain better agreement. DOE

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A93-24780*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A NEW PROCEDURE FOR DYNAMIC ADAPTION OF THREE-DIMENSIONAL UNSTRUCTURED GRIDS

RUPAK BISWAS (NASA, Ames Research Center, Moffett Field, CA) and ROGER STRAWN (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 13 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
 (AIAA PAPER 93-0672)

A new procedure is presented for the simultaneous coarsening and refinement of three-dimensional unstructured tetrahedral meshes. This algorithm allows for localized grid adaption that is used to capture aerodynamic flow features such as vortices and shock waves in helicopter flowfield simulations. The mesh-adaption algorithm is implemented in the C programming language and uses a data structure consisting of a series of dynamically-allocated linked lists. These lists allow the mesh connectivity to be rapidly reconstructed when individual mesh points are added and/or deleted. The algorithm allows the mesh to change in an anisotropic manner in order to efficiently resolve directional flow features. The procedure has been successfully implemented on a single processor of a Cray Y-MP computer. Two sample cases are presented involving three-dimensional transonic flow. Computed results show good agreement with conventional structured-grid solutions for the Euler equations. Author

A93-24781*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

UNSTRUCTURED 3D DELAUNAY MESH GENERATION APPLIED TO PLANES, TRAINS AND AUTOMOBILES

KENNETH R. BLAKE and GREGORY S. SPRAGLE (Fluent, Inc., Lebanon, NH) Jan. 1993 16 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
 (Contract NAS3-25785)

(AIAA PAPER 93-0673) Copyright

Technical issues associated with domain-tessellation production, including initial boundary node triangulation and volume mesh refinement, are presented for the 'TGrid' 3D Delaunay unstructured grid generation program. The approach employed is noted to be capable of preserving predefined triangular surface facets in the final tessellation. The capabilities of the approach are demonstrated by generating grids about an entire fighter aircraft configuration, a train, and a wind tunnel model of an automobile. O.C.

A93-24960#

DEVELOPMENT OF A ROBUST PRESSURE-BASED NUMERICAL SCHEME FOR SPRAY COMBUSTION APPLICATIONS

PAK-YAN LIANG and DANIEL C. CHAN (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
 (AIAA PAPER 93-0902) Copyright

A proven pressure-based scheme originally designed for incompressible turbomachinery applications is extended to multiphase multispecies supersonic flows. Qualitative and some quantitative test cases are examined for each of the three areas of major extensions of the current scheme: a conical nozzle, curved channel cavitating flow, and gaseous oxygen-hydrogen shear flow. Preliminary results demonstrate the possibility of substantially enhancing the robustness of the new codes in comparison with the earlier generation spray combustion codes. V.L.

A93-25085

CST AND ROTORCRAFT - EXPANDING THE VIEW

JAMES CRONKHITE (Bell Helicopter Textron, Inc., Fort Worth, TX), WILLIAM TWOMEY (Sikorsky Aircraft, Stratford, CT), and PHILLIP LANG (Boeing Co., Helicopters Div., Philadelphia, PA) Aerospace America (ISSN 0740-722X) vol. 31, no. 2 Feb. 1993 p. 28-31.

Copyright

The increasing role of computational structures technology (CST) in rotorcraft development is discussed. In particular, powerful new computers are permitting engineers to create larger rotorcraft models that provide more detail and greater accuracy. The use of CST in the design of rotorcraft structures for crash tests is addressed. Future trends in the use of CST in rotorcraft technology are examined. C.D.

A93-25086

CST GIVES AIRCRAFT INDUSTRY A LIFT

HARRY ARMEN (Grumman Corp., Bethpage, NY), RODNEY DREISBACH (Boeing Commercial Airplane Group, Seattle, WA), CHARLES ORKISZEWSKI (General Electric Co., Fairfield, CT), and FRANK ABDI (Rockwell International Corp., El Segundo, CA) Aerospace America (ISSN 0740-722X) vol. 31, no. 2 Feb. 1993 p. 32-35, 43.

Copyright

The role of computational structures technology (CST) tools and methods in developing innovative designs, new materials, and advanced structural concepts in aircraft industry is discussed. Emphasis is on finite element modeling of commercial aircraft, including the Boeing 777, which will be designed entirely by computers. C.D.

A93-25088

EUROPE ADAPTS CST TO ITS NEEDS

MICHEL GERADIN (Liege Univ., Belgium) and CHRISTIAN CORNUAULT (Dassault Aviation, Saint-Cloud, France) Aerospace America (ISSN 0740-722X) vol. 31, no. 2 Feb. 1993 p. 40-43.

Copyright

The development of computational structure technology (CST) for aerospace R&D in Europe is discussed. Innovative CST work being done by various French aerospace organizations is described. The most important themes of current European CST work are indicated. C.D.

A93-25339**MESH3D - A TOOL FOR THE CONSTRUCTION OF THREE-DIMENSIONAL MESHES [MESH3D - UN OUTIL POUR LA CONSTRUCTION DE MAILLAGES TRIDIMENSIONNELS]**

F. MONTIGNY-RANNOU and O. P. JACQUOTTE (ONERA, Chatillon, France) ONERA, TP no. 1992-164 1992 37 p. In French. Research supported by Service Technique des Programmes Aeronautiques refs (ONERA, TP NO. 1992-164)

The MESH3D code, a 3D algebraic mesh for the numerical-simulation study of problems of aerodynamics, is described. It furnishes Euler-type or Navier-Stokes-type meshes around various types of configurations, and, written in FORTRAN77, is portable to any type of computer. Results obtained for different aerodynamic configurations are presented by way of illustration. L.M.

A93-26838**A NONSEARCH ADAPTIVE CONTROL SYSTEM WITH A REFERENCE MODEL AND DERIVATIVE MEASUREMENT [BESPOISKOVAIA ADAPTIVNAIA SISTEMA UPRAVLENIIA S ETALONNOI MODEL'IU I IZMERENIEM PROIZVODNYKH]**

E. P. RESHETNIAK (Kievskoe Vysshee Voennoe Aviatsionnoe Inzhenernoe Uchilishche, Kiev, Ukraine) Avtomatika i Telemekhanika (ISSN 0005-2310) no. 11 Nov. 1992 p. 101-108. In Russian. refs Copyright

For a linear plant with one input and one output, an adaptive control algorithm with a reference model and measurement of the output signal derivative is considered which employs a nonminimal form of the plant model and Kalman filtering methods. Conditions for achieving the adaptation objectives are investigated. An example is presented which involves the synthesis of an adaptive control system for maintaining the stability and controllability of a hypothetical aircraft flying at a height of 18,000 m at Mach 1.7. V.L.

A93-27150**THE DEVELOPMENT OF THE BOEING HUMAN MODEL**

R. C. UNDERWOOD, D. L. HILBY, T. B. HOLZHAUSER, and B. E. TEDLUND (Boeing Commercial Airplane Group, Seattle, WA) In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 127-131. Copyright

This paper summarizes the methodology and lessons learned in the development of the Boeing Human Model. In our efforts to implement human modeling with Computer Aided Design at Boeing Commercial Airplane Group (BCAG) several externally-developed programs were reviewed. Each system had unique strengths, but none satisfied our requirements for broad utilization. A human modeling program was developed internally which complied with a set of application-oriented development guidelines. Compliance with these guidelines during development led to a high level of utilization by engineering users. The cost of broadly implementing the model, however, was increased development time. Additional functions, such as strength modeling and animation, are required by our users. To accelerate the development of additional functions we may obtain support from other software development sources. Full understanding of our development guidelines will help ensure that additional functions can be fully integrated into our routine engineering operations. Author

A93-27584**NUMERICAL SIMULATION OF HOMOGENEOUS NON-GAUSSIAN RANDOM VECTOR FIELDS**

F. POIRION (ONERA, Chatillon, France) Journal of Sound and

Vibration (ISSN 0022-460X) vol. 160, no. 1 Jan. 8, 1993 p. 25-42. refs

Copyright

A method which constructs numerical simulations of homogeneous non-Gaussian random vector fields is given. It uses multi-dimensional pulse trains with Poisson arrival times. It is first shown that the classical results concerning one-dimensional filtered Poisson process can be generalized to the multi-dimensional case. It is then explained how to determine the multi-dimensional filtered Poisson process in order to match the spectral density matrix and the first statistical moments of the given non-Gaussian random field. This method is used in order to construct non-Gaussian simulation of wind. Finally, the sensitivity of the response of a nonlinear dynamical system excited by a random process to the input law is illustrated by an example. Author

A93-27603**CONTROL SYNTHESIS WITH INCOMPLETE, COMPLETE, AND SUPERCOMPLETE MEASUREMENTS [SINTEZ UPRAVLENIIA S NEPOLNYM, POLNYM I SVERKHPOLNYM IZMERENIEM]**

A. A. BALOEV and A. A. GUSEV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 10-16. In Russian. refs Copyright

The problem of optimal control synthesis is solved for the case of complete measurements, and the suboptimal control synthesis problem is solved for the cases of incomplete and supercomplete measurements. The control of the longitudinal motion of a flight vehicle in the case where only some of the phase coordinates are measured is considered as an example. V.L.

A93-27629**A SET OF APPLICATION PROGRAMS FOR THE SMOOTHING OF CURVES AND SURFACES BY THE METHOD OF MONOIDAL TRANSFORMATIONS IN THE GEOMETRIC MODULE OF A CAD SYSTEM FOR THE DESIGN OF FLIGHT VEHICLES [KOMPLEKS PRIKLADNYKH PROGRAMM DLIA SGLAZHIVANIYA KRIVYKH I POVERKHNOSTEI METODOM MONOIDAL'NYKH PREOBRAZOVANII V GEOMETRICHESKOM MODULE SAPR LA]**

V. I. IAKUNIN and B. N. NURMAKHANOV Aviatsonnaia Tekhnika (ISSN 0579-2975) no. 2 1992 p. 109-112. In Russian. refs

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The method of nonlinear monoidal transformations is used for the mathematical description of a geometrical model of curves and surfaces. Based on this approach, a set of software has been developed for the geometrical modeling of curves and surfaces that satisfy specified requirements. The software is incorporated into the geometrical module of a CAD system for the design of flight vehicles. Details of the method for specifying curves and surfaces using third-order monoidal transformations are included. V.L.

A93-27688**A STUDY OF THE PROBLEM OF DEVELOPING A WEAKLY INVARIANT FLIGHT VEHICLE CONTROL SYSTEM [ISSLEDOVANIIE ZADACHI POSTROENIIA SLABO INVARIANTNOI SISTEMY UPRAVLENIIA LETATEL'NYM APPARATOM]**

E. M. SOLNECHNYI (RAN, Inst. Problem Upravleniia, Moscow, Russia) Avtomatika i Telemekhanika (ISSN 0005-2310) no. 1 Jan. 1993 p. 50-61. In Russian. refs

Copyright

Several possible method of solving the problem of synthesis of a weakly invariant flight vehicle control system, designed for high-precision landing, are investigated. Each of the methods considered involves calculating (prior to the flight) the sensitivity functions of the landing point with respect to the initial state vector, which makes it possible to predict the landing point during flight and form the control as a function of this prediction. Results of computer calculations of the landing point error are presented. V.L.

A93-27689

AN IDENTIFICATION METHOD FOR DYNAMIC SYSTEMS WITH DELAY (METOD IDENTIFIKATSII DINAMICHESKIKH SISTEM S ZAPAZDYVANIEM)

B. O. KACHANOV and K. B. KHROLOVICH (Voenno-Vozdushnaia Inzhenernaia Akademiia, Moscow, Russia) *Avtomatika i Telemekhanika* (ISSN 0005-2310) no. 1 Jan. 1993 p. 67-72. In Russian. refs

Copyright

A method is proposed for the identification of dynamic systems containing constant delay links in their structure. By using a two-sided symmetric Laplace transform, the identification procedure is reduced to that of solving a regression problem. The accuracy of the method is estimated. V.L.

A93-29422* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DATA ACQUISITION AND ANALYSIS ON A MACINTOSH

MICHAEL E. WATTS and MEGAN M. ST. JEAN (NASA, Ames Research Center, Moffett Field, CA) *In AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics*, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 21 p. refs

Copyright

The introduction of inexpensive analog-to-digital boards for the Macintosh opens the way for its use in areas that have previously been filled by either specialized, dedicated or more expensive mainframe based systems. Two such Macintosh-based systems are the Acoustic Laboratory Data Acquisition System (ALDAS) and the Jet Calibration and Hover Test Facility (JCAHT) data acquisition system. ALDAS provides an inexpensive, transportable means to digitize four channels at up to 50,000 samples per second and analyze this data. The ALDAS software package was written for use with rotorcraft acoustics and performs automatic acoustic calibration of channels, data display, and various types of data analysis. The program can use data obtained either from internal analog-to-digital conversion or discrete external data imported in ASCII format. All aspects of ALDAS can be improved as new hardware becomes available and new features are introduced into the code. The JCAHT data acquisition system was built as not only an analysis program but also to act as the online safety monitoring system. This paper will provide an overview of these systems. Author

A93-29423* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ADDRAS - AN INTEGRATED SYSTEMS APPROACH

LAWRENCE E. BECKER, CHARLES K. RUTLEDGE (Lockheed Engineering and Sciences Co., Hampton, VA), ROBERT E. GRANDLE, ROBERT A. GOLUB (NASA, Langley Research Center, Hampton, VA), and RITA A. SMITH (Lockheed Engineering and Sciences Co., Hampton, VA) *In AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics*, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. refs

Copyright

NASA-Langley's Acoustics Division Data Reduction and Analysis System (ADDRAS) computes far-field noise spectral estimates on the basis of weather, aircraft state and position, and acoustic data sets. The structure and function of ADDRAS has been primarily determined by rotorcraft flyover test design, data acquisition, and data flow criteria. The RIM relational database management software is used to organize all noise test data for ADDRAS.

O.C.

A93-29690

ALGORITHMS AND AUTOMATED TECHNIQUES FOR THE DESIGN OF CONTROL SYSTEMS FOR MOVING OBJECTS [ALGORITMICHESKOE I TEKHNICHESKOE OBESPECHENIE PROEKTIROVANIIA SISTEM UPRAVLENIIA DVIZHUSHCHIMISIA OB'EKTAMI]

G. D. KOKOREV, ED. Moscow Izdatel'stvo Moskovskogo Aviatsonnogo Instituta 1991 111 p. In Russian. Copyright

The papers presented in this volume focus on the theory of control systems and automation of the design of such systems. Topics discussed include a method for increasing the accuracy of a system for determining the angular position of objects, design of logic control algorithms for complex technological systems, estimation of the number of operators and their efficiency in flight vehicle control, and estimation of the accuracy of identification from a small number of discrete observations. Papers are also presented on the observation of the phase characteristics of nonlinear processes in the case of incomplete information, analysis of the noise immunity of self-tuning optoelectronic systems in the moving object tracking mode, and construction of optimal spatial transfers in a gravitational field in the presence of constraints. (For individual items see A93-29691 to A93-29705) V.L.

N93-21820# Bombardier, Inc., Montreal (Quebec). Canadair Div.

FURTHER DEVELOPMENT OF THE CANAERO COMPUTER CODE TO INCLUDE A TIME-STEPPING CAPABILITY Final Report

J. CONWAY and F. TEZOK Oct. 1991 127 p (DREA-CR-91-478; CTN-93-60715; RAZ-000-563) Avail: CASI HC A07

The CANAERO panel method has been successfully extended to perform unsteady incompressible inviscid calculations using a time-stepping procedure with wake convection. The new program, called CANAERO-T, provides an unsteady potential flow panel method for calculating the flow around, and forces and moments on, complex configurations. CANAERO-T has been interfaced with the OMNILOT graphics package to permit animated displays of geometry and aerodynamics. The implementation and testing of the new CANAERO-T unsteady code are described, together with a description of the mathematical formulation of the method, some features of which appear to be unique to CANAERO-T. Results from CANAERO-T are presented for the following test cases: an impulsively started wing; an impulsively started oscillating wing; two impulsively started wings with one located in the slipstream of the other; a 3-bladed marine propeller; an impulsively started submarine at 9 degrees of drift; and a maneuvering submarine. The results have shown that unsteady effects are crucial in calculating the forces and moments on a hull plus sail configuration during a turn maneuver. Author (CISTI)

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A93-24726#

AN INTERACTION NOISE BETWEEN VORTEX AND AIRFOIL

JINZHANG FENG, CHARLES L. MERKLE (Pennsylvania State Univ., University Park), and YU-TAI LEE (U.S. Navy, David Taylor Model Basin, Bethesda, MD) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Research supported by U.S. Navy refs (AIAA PAPER 93-0600) Copyright

This paper is concerned with increasing the understanding of the noise generation mechanism between turbomachinery blades and shed vorticity by developing a computational method that predicts the flow interaction unsteadiness and the resultant acoustic pressures due to acceleration/deceleration of vortices and airfoils. This code has been used to study the generation of shed vorticity and the interaction between a vortex and both an airfoil and a

cascade in terms of flow interaction phenomena, force acting on the airfoil, instability of the travelling vortex locations, and the radiated acoustic pressure. Author

A93-24727*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EFFECT OF LEADING-EDGE POROSITY ON BLADE-VORTEX INTERACTION NOISE

SOOGAB LEE (Sterling Federal Systems, Inc.; NASA, Ames Research Center, Moffett Field, CA) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0601) Copyright

The effect of the porous leading-edge of an airfoil on the blade-vortex interaction noise, which dominates far-field acoustic spectrum of the helicopter, is investigated. The thin-layer Navier-Stokes equations are solved with a high-order upwind-biased scheme and a multizonal grid system. The Baldwin-Lomax turbulence model is modified for considering transpiration on the surface. The amplitudes of the propagating acoustic wave in the near-field are calculated directly from the computation. The porosity effect on the surface is modeled. Results show leading-edge transpiration can suppress pressure fluctuations at the leading-edge during BVI, and consequently reduce the amplitude of propagating noise by 30 percent at maximum in the near-field. The effect of porosity factor on the noise level is also investigated. Author

A93-24783*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ACOUSTIC MODE MEASUREMENTS IN THE INLET OF A MODEL TURBOFAN USING A CONTINUOUSLY ROTATING RAKE

LAURENCE J. HEIDELBERG (NASA, Lewis Research Center, Cleveland, OH) and DAVID G. HALL (Sverdrup Technology, Inc., Brook Park, OH) Jan. 1993 31 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Previously announced in STAR as N93-16705 refs
(AIAA PAPER 93-0598) Copyright

Comprehensive measurements of the spinning acoustic mode structure in the inlet of the Advanced Ducted Propeller (ADP) have been completed. These measurements were taken using a unique and previously untried method which was first proposed by T.G. Sofrin. A continuously rotating microphone system was employed. The ADP model was designed and built by Pratt & Whitney and tested in the NASA Lewis 9- by 15-foot Anechoic Wind Tunnel. Three inlet configurations were tested with cut-on and cutoff stator vane sets. The cutoff stator was designed to suppress all modes at the blade passing frequency. Rotating rake measurements indicate that several extraneous circumferential modes were active. The mode orders suggest that their source was an interaction between the rotor and small interruptions in the casing tip treatment. The cut-on stator produced the expected circumferential modes plus higher levels of the unexpected modes seen with the cutoff stator. Author

A93-24821*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MEASURED ACOUSTIC CHARACTERISTICS OF DUCTED SUPERSONIC JETS AT DIFFERENT MODEL SCALES

R. R. JONES, III (Sverdrup Technology, Inc., Arnold AFB, TN), K. K. AHUJA (Georgia Inst. of Technology, Atlanta), CHRISTOPHER K. W. TAM (Florida State Univ., Tallahassee), and M. ABDELWAHAB (NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 12 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0731)

A large-scale (about a 25x enlargement) model of the Georgia Tech Research Institute (GTRI) hardware was installed and tested in the Propulsion Systems Laboratory of the NASA Lewis Research Center. Acoustic measurements made in these two facilities are compared and the similarity in acoustic behavior over the scale range under consideration is highlighted. The study provide the

acoustic data over a relatively large-scale range which may be used to demonstrate the validity of scaling methods employed in the investigation of this phenomena. O.G.

A93-24825*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPUTATION OF SUPERSONIC JET NOISE UNDER IMPERFECTLY EXPANDED CONDITIONS

CHAN M. KIM, EUGENE A. KREJSA (NASA, Lewis Research Center, Cleveland, OH), and ABBAS KHAVARAN (Sverdrup Technology, Inc., Brook Park; NASA, Lewis Research Center, Cleveland, OH) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 Previously announced in STAR as N93-15430 refs
(AIAA PAPER 93-0735) Copyright

The turbulent mixing noise of supersonic jet under imperfectly expanded conditions is calculated for convergent and convergent-divergent (CD) axisymmetric nozzle geometries. The noise prediction incorporates CFD solution of Navier-Stokes equations. The effect of grid resolution on shock structure computation is demonstrated. Mixing noise spectra predicted from fine and coarse grid solutions exhibit little sensitivity to the grid resolution. A proper grid resolution, however, results in a significant improvement in shock capturing capability and helps predictions agree favorably with experimental data. Good agreement between predicted noise spectra and data shows that the CFD-incorporated noise prediction scheme, which was demonstrated for shock-free conditions, works as well for shock-containing flow conditions. Author

A93-24826*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SIGNAL PROCESSING OF JET NOISE FROM FLYOVER TEST DATA

JEFFREY J. KELLY and MARK R. WILSON (Lockheed Engineering & Sciences Co., Hampton, VA) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(Contract NAS1-19000)
(AIAA PAPER 93-0736) Copyright

Narrow-band spectra characterizing jet noise are constructed from flyover acoustic measurements. Radar and c-band tracking systems provided the aircraft position histories which enabled directivity and smear angles from the aircraft to each microphone to be computed. These angles are based on source emission time and thus give some idea about the directivity of the radiated sound field due to jet noise. Simulated spectra are included in the paper to demonstrate spectral broadening due to smear angle. The acoustic data described in the study has application to community noise analysis, noise source characterization and validation of prediction models. Both broadband-shock noise and turbulent mixing noise are observed in the spectra. A detailed description of the signal processing procedures is provided. Author

A93-24827*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DE-DOPPLERIZATION OF AIRCRAFT ACOUSTIC SIGNALS

JEFFREY J. KELLY and MARK R. WILSON (Lockheed Engineering & Sciences Co., Hampton, VA) Jan. 1993 11 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(Contract NAS1-19000)
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A de-Dopplerization scheme is devised and applied to both a tonal noise source, a XV-15 aircraft, and a broadband noise source, a F-18 aircraft. The procedure is developed from the conservation equations of fluid mechanics and is described in the paper. The corrected time history is constructed by using linear interpolation in the measured time history. This was made possible by knowing the position history of the aircraft provided by radar and/or laser tracking. The XV-15 data established that the scheme can accurately account for Doppler frequency shifts. The F-18 data

confirms what has been noted in prediction models and static tests pertaining to broadband shock associated noise. That is, the peak frequency increases and the peaks broaden toward the jet axis. Another issue addressed in the study is the influence of correcting for spherical spreading and Doppler amplitude on the spectral shape and overall sound pressure levels of the source. Results from this investigation confirm that the dominant noise source in high-speed jets is due to turbulent mixing. Author

A93-25504#**A THIRD ORDER UPWIND SCHEME FOR AERO-ACOUSTIC APPLICATIONS**

L. N. SANKAR (Georgia Inst. of Technology, Atlanta), N. N. REDDY (Lockheed Aeronautical Systems Co., Marietta, GA), and NATHAN HARIHARAN (Georgia Inst. of Technology, Atlanta) Jan. 1993 10 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs (AIAA PAPER 93-0149) Copyright

An implementation of an upwind multidimensional upwind scheme for aeroacoustic phenomena calculations is presented that is second-order accurate in time and third-order accurate in space. The scheme allows (1) nonuniform mean flows with embedded shock waves, and (2) prescription of such internal or external acoustic sources as plane acoustic waves, monopoles, dipoles, and distributed-body forces. The scheme has built-in numerical viscosity, which is automatically tuned to be proportional to the speed of the individual family of the waves. Illustrative results are presented. O.C.

A93-28180**THE HISTORY AND DEVELOPMENT OF COATED CONTRAST ENHANCEMENT FILTERS FOR COCKPIT DISPLAYS**

CLIFFORD E. SISLER (Metavac, Inc., Flushing, NY) /n Sensors and sensor systems for guidance and navigation II; Proceedings of the Meeting, Orlando, FL, Apr. 22, 23, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 285-297. Copyright

The development of the coated Contrast Enhancement Filters, the coated narrow band-pass absorbing optical filters designed for P43 CRT color shadow mask displays and flat panel displays is discussed. Particular attention is given to the properties and applications of several series of Contrast Enhancement Filters, including filters designed to meet special day-night application. I.S.

A93-28480**COMPARISON OF AIRPORT NOISE CALCULATION MODELS**

KARE H. LIASJO, IDAR L. N. GRANOIEN (Norwegian Inst. of Technology, Trondheim, Norway), and ROBERT A. LEE (USAF, Armstrong Aerospace Medical Research Lab., Wright-Patterson AFB, OH) /n Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 187-190. Copyright

Different airport noise calculation models are evaluated, and calculation measurement results of the same traffic situations are compared. All models are used to produce both aircraft noise contours and grid calculations at 18 points; at all points high-quality noise measurements are made as well. Differences caused by algorithms and data bases in use by each model are explained, and the accuracy of each model is determined. C.A.B.

A93-28482**THE AIRNOISE BOUNDARY CONCEPT FOR AIRPORT NOISE MANAGEMENT**

PHILIP J. DICKINSON (Department of Health, Wellington, New Zealand) /n Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 195-198. refs Copyright

Attention is given to the draft New Zealand Standard on Airport Noise, which tells airport users exactly how much noise exposure they may make over any residential area; only in a fixed airport control zone, enclosed by the 'airnoise boundary', may they make more noise than this amount. The airnoise boundary concept for airport noise management is argued to be feasible and applicable to any airport irrespective of size. Use of the concept may greatly ease the related health problems around many busy airports, and still allow for necessary growth. C.A.B.

A93-28489**SOUND EXPOSURE SPECTRUM LEVELS OF SONIC BOOMS**

VELYN C. YOUNG /n Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 1 Poughkeepsie, NY Noise Control Foundation 1991 p. 349-352. Copyright

The study by Young (1991) on sonic boom spectra of the Space Shuttle Columbia landing of December 10, 1991 is extended to C- and A-weighted sound exposure spectrum levels. The C-weighted sound exposure spectrum level (1-Hz CSEL) is shown up to 1000 Hz. The wideband C-weight sound exposure level of the sonic boom, when Columbia was descending at Mach 1.4 almost directly 17.7 km over the microphones, was 109 dB. A dominant part of the A-weighted sound exposure level spectrum of a sonic boom is shown to lie between 50 and 800 Hz, with a broad maximum around 200 Hz. C.A.B.

A93-28492**TECHNICAL SOLUTIONS TO REDUCE AND TO CONTROL THE NOISE LOAD IN THE NETHERLANDS**

GERARD BEKEBREDE (National Aerospace Lab., Amsterdam, Netherlands) /n Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 2 Poughkeepsie, NY Noise Control Foundation 1991 p. 769-772. Copyright

The research conducted by the National Aerospace Laboratory NLR of the Netherlands related to the environmental problems caused by aircraft is summarized. Attention is given to investigations of the acoustic treatment of aircraft engines, research into minimum noise routes, and the realization of monitoring systems in the surroundings of airports. C.A.B.

A93-28494**AIR TRAFFIC NOISE MONITORING IN AND AROUND LISBON AIRPORT**

J. L. BENTO COELHO and ANTONIO FERREIRA (Inst. Superior Tecnico, Lisbon, Portugal) /n Inter-noise '91; Proceedings of the 20th International Conference on Noise Control Engineering, Sydney, Australia, Dec. 2-4, 1991. Vol. 2 Poughkeepsie, NY Noise Control Foundation 1991 p. 793-796. Research sponsored by Aeroportos e Navegacao Aerea Copyright

Results are presented of a study to assess the extent of the impact of air traffic noise from Lisbon Airport on Lisbon's environment, to plan the location of the noise monitoring terminals, and to set up the data processing procedures. The influence of the air traffic noise in Lisbon is found to be predominantly over a limited area around the airport. This fact, together with analysis and prediction techniques, could minimize the number of noise monitoring terminals, thereby lowering the cost/benefit ratio. C.A.B.

A93-28609* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CRUISE NOISE OF AN ADVANCED PROPELLER WITH SWIRL RECOVERY VANES

JAMES H. DITTMAR (NASA, Lewis Research Center, Cleveland, OH) and DAVID G. HALL (Sverdrup Technology, Inc., Brook Park, OH) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 221-226. Previously cited in issue 02, p. 228, Accession

no. A91-12448 refs
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A93-28614
ROLE OF LEADING-EDGE VORTEX FLOWS IN PROP-FAN INTERACTION NOISE

J. C. SIMONICH, D. C. MCCORMICK, and P. L. LAVRICH (United Technologies Research Center, East Hartford, CT) *Journal of Aircraft* (ISSN 0021-8669) vol. 30, no. 2 Mar.-Apr. 1993 p. 255-261. Research supported by United Technologies Corp refs

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An experimental investigation has been carried out to study the interaction mechanisms associated with wakes from unswept, aft-, and forward-swept vanes incident on rotating prop-fan blades. Wakes from a single, stationary upstream vane interacted with a single rotating prop-fan. Comprehensive flowfield and acoustic measurements were acquired over a range of takeoff operating conditions. The forward-swept vane caused the leading-edge vortex and a core velocity defect associated with it to move inboard towards the hub and away from the high-speed tip region of the prop-fan. The tip vortex had only a small axial velocity disturbance associated with it. This is in contrast to the aft-swept vane which directed the leading-edge vortex out towards the tip, and led a large axial velocity disturbance to be swept toward the prop-fan tip region. Noise measurements revealed that the forward-swept vane wakes generated relatively less interaction noise than the aft-swept vane wakes, at equivalent vane loadings. From this simulation study, a potential noise reduction strategy for the counter-rotating prop-fan is suggested which uses a forward-swept/aft-swept counter-rotating prop-fan combination. By reducing the sweep or modifying the spanwise loading on the blades, it may be possible to control the magnitude and/or location of the velocity defect associated with the leading-edge vortex.

Author

A93-29401
AHS AND ROYAL AERONAUTICAL SOCIETY, TECHNICAL SPECIALISTS' MEETING ON ROTORCRAFT ACOUSTICS/FLUID DYNAMICS, PHILADELPHIA, PA, OCT. 15-17, 1991, PROCEEDINGS

Alexandria, VA American Helicopter Society 1991 703 p. Copyright

The present conference discusses helicopter blade-vortex interaction (BVI) sound generation and directionality, shock waves in high speed helicopter rotors, higher-harmonic control of BVI noise, blade elasticity effects in BVI prediction, transonic BVI noise reduction, far-field acoustic characteristics of tilt-rotor advanced blades in hover, tilt-rotor ground-noise reduction, and the validation of 'quiet tail rotor' technology. Also discussed are the 'NOTAR' system, an acoustical analysis of gear housing vibration, tilt-rotor interior noise, human response to helicopter noise, frequency-shaped control of active isolators, a CFD potential method for tilt rotors, rotor wake modeling for noise prediction, passive drag reduction for a helicopter rotor airfoil, and helicopter noise standards. (For individual items see A93-29402 to A93-29430, A93-29432 to A93-29443)

O.C.

A93-29402* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A STUDY OF BLADE-VORTEX INTERACTION SOUND GENERATION AND DIRECTIONALITY

TODD D. RINGLER, ALBERT R. GEORGE, and JAMES B. STEELE (Cornell Univ., Ithaca, NY) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 21 p. refs

(Contract NAS1-19145)

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The directionality and strength of blade-vortex interactions (BVI) is explained through the radiation cone concept. BVI acoustic radiation is primarily the result of two sound mechanisms: the tip

effect, and the radiation cone effect. The radiation cone effect is a highly directional mechanism which results when a lift distribution moves supersonically with respect to the fluid. After a physical explanation of the BVI mechanisms, sample cases using translating and rotating blades interacting with a straight line vortex are shown. The radiation cone concept is then applied to specific rotorcraft cases where it helps to explain zones of intense sound pressure level found in experimental results for the XV-15 tiltrotor and for a BO-105 helicopter scale model.

Author

A93-29403* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HIGH-SPEED HELICOPTER ROTOR NOISE - SHOCK WAVES AS A POTENT SOURCE OF SOUND

F. FARASSAT, YUNG-JANG LEE (NASA, Langley Research Center, Hampton, VA), H. TADGHIGHI, and R. HOLZ (McDonnell Douglas Helicopter Co., Mesa, AZ) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 8 p. refs

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In this paper we discuss the problem of high speed rotor noise prediction. In particular, we propose that from the point of view of the acoustic analogy, shocks around rotating blades are sources of sound. We show that, although for a wing at uniform steady rectilinear motion with shocks the volume quadrupole and shock sources cancel in the far field to the order of $1/r$, this cannot happen for rotating blades. In this case, some cancellation between volume quadrupoles and shock sources occurs, yet the remaining shock noise contribution is still potent. A formula for shock noise prediction is presented based on mapping the deformable shock surface to a time independent region. The resulting equation is similar to Formulation 1A of Langley. Shock noise prediction for a hovering model rotor for which experimental noise data exist is presented. The comparison of measured and predicted acoustic data shows good agreement.

Author

A93-29404* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SENSITIVITY OF ACOUSTIC PREDICTIONS TO VARIATION OF INPUT PARAMETERS

KENNETH S. BRENTNER, MICHAEL A. MARCOLINI, and CASEY L. BURLEY (NASA, Langley Research Center, Hampton, VA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 11 p. refs

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The noise prediction code WOPWOP predicts the thickness and loading noise produced by a helicopter rotor, given the blade motion, rotor operating conditions, and fluctuating force distribution over the blade surface. However, the criticality of these various inputs, and their respective effects on the predicted acoustic field, have never been fully addressed. This paper examines the importance of these inputs, and the sensitivity of the acoustic predictions to a variation of each parameter. The effects of collective and cyclic pitch, as well as coning and flapping, are presented. Blade loading inputs are examined to determine the necessary spatial and temporal resolution, as well as the importance of the cordwise distribution. The acoustic predictions show regions in the acoustic field where significant errors occur when simplified blade motions or blade loadings are used. An assessment of the variation in the predicted acoustic field is balanced by a consideration of CPU time necessary for the various approximations.

Author

A93-29405* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HHC STUDY IN THE DNW TO REDUCE BVI NOISE - AN ANALYSIS

THOMAS F. BROOKS, EARL R. BOOTH, JR., D. D. BOYD, JR. (NASA, Langley Research Center, Hampton, VA), WOLF R.

SPLETTSTOESSER, KLAUS -J. SCHULTZ, ROLAND KUBE (DLR, Braunschweig, Germany), GEORG H. NIESL (MBB GmbH, Munich, Germany), and OLIVIER STREBY (Aerospatiale, Div. Helicopteres, Marignane, France) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. refs

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The noise of an aeroelastically scaled helicopter rotor has been studied in the German-Dutch wind tunnel in order to assess the utility of higher-harmonic control (HHC) in reducing blade-vortex interaction (BVI) noise. Acoustic data are presented for 3/rev, 4/rev, and 5/rev HHC, as applied to a typical landing approach rotor operating condition; noise reduction of up to 6 dB were found for advancing-blade BVI noise radiating upstream of the rotor, as well as for retreating blade BVI noise radiating below and downstream of the rotor. O.C.

A93-29406

THE ROLE OF BLADE ELASTICITY IN THE PREDICTION OF BLADE-VORTEX INTERACTION NOISE

ROBERT C. DERHAM (Boeing Defense & Space Group, Philadelphia, PA) and BYUNG K. OH (Boeing Computer Services, Philadelphia, PA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 10 p. refs

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An analytical study of the role of a main rotor blade's flap, chord and torsional stiffnesses on vibratory airloads and sound pressures has been carried out. A rotor analysis code typically applied to blade dynamics and performance was modified to capture the airload due to blade-vortex and blade-wake interaction by using a finer azimuthal computation grid. The blade elasticity of the composite blade in this study is shown to have a significant influence upon the noise caused by blade-vortex interactions; the predicted sound pressures are shown to be especially sensitive to torsional stiffness. The effect of frequency placement and control system stiffness on sound levels is also discussed. Author

A93-29407

THEORETICAL MODELLING OF ROTOR NOISE RADIATION

M. V. LOWSON, J. A. G. ASTON, S. P. FIDDES, and J. GOULD (Bristol Univ., United Kingdom) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 22 p. refs

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A novel method is presented for the numerical evaluation of the Ffowcs Williams-Hawkings equation used in determining the noise radiation field of rotors/propellers. Attention is given to the cases of (1) hover, and (2) where the observer is stationary with respect to the uniform translational motion of the rotor/propeller. The method is further employed to address high-speed impulsive noise, and, in conjunction with lifting-line theory, to predict the noise-radiation field of two different types of propellers. O.C.

A93-29408* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

NOISE REDUCTION FOR TRANSONIC BLADE-VORTEX INTERACTIONS

Y. XUE and A. S. LYRINTZIS (Minnesota Univ., Minneapolis) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. Research supported by Univ. of Minnesota refs

(Contract NAG2-646)

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Several ideas for noise reduction of transonic blade-vortex

interactions (BVI) are being introduced and tested using numerical simulation. The model used is the two-dimensional high frequency transonic small disturbance equation with regions of distributed vorticity (VTRAN2 code). The far-field noise signals are obtained by using the Kirchhoff method which extends the numerical two-dimensional near-field aerodynamic results to the linear acoustic three-dimensional far-field. The BVI noise mechanisms are explained and the effects of vortex type and strength, and angle of attack are studied. Particularly, airfoil shape modifications which lead to noise reduction are investigated here. The results presented are expected to be helpful for better understanding of the nature of the BVI noise and better blade design. Author

A93-29409

THE DEVELOPMENT OF A PREDICTION METHOD FOR THE CALCULATION OF BLADE-VORTEX INTERACTION NOISE BASED ON MEASURED AIRLOADS

PERRY R. ZIEGENBEIN (Boeing Defense & Space Group, Philadelphia, PA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. refs

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The preliminary development of a blade-vortex interaction airload model for use in acoustic prediction is described. A sinusoid model of the high frequency pressure fluctuations due to direct encounter blade-vortex interactions is shown to be adequate for acoustic predictions. Author

A93-29410* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

THE INFLUENCE OF QUADRUPOLE SOURCES IN THE BOUNDARY LAYER AND WAKE OF A BLADE ON HELICOPTER ROTOR NOISE

F. FARASSAT and KENNETH S. BRENTNER (NASA, Langley Research Center, Hampton, VA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 7 p. refs

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It is presently noted that, for an observer in or near the plane containing a helicopter rotor disk, and in the far field, part of the volume quadrupole sources, and the blade and wake surface quadrupole sources, completely cancel out. This suggests a novel quadrupole source description for the Ffowcs Williams-Hawkings equation which retain quadrupoles with axes parallel to the rotor disk; in this case, the volume and shock surface source terms are dominant. O.C.

A93-29412 National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

FAR-FIELD HOVER ACOUSTIC CHARACTERISTICS OF THE XV-15 TILTROTOR AIRCRAFT WITH ADVANCED TECHNOLOGY BLADES

DAVID A. CONNER (U.S. Army, Aerostructures Directorate; NASA, Langley Research Center, Hampton, VA) and BRENT WELLMAN (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 23 p. refs

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An experimental investigation has been conducted with the XV-15 tilt-rotor VTOL aircraft in order to ascertain the noise-reduction efficacy of Advanced Technology Blades (ATBs). Attention is given to acoustic directivity characteristics in the lower hemisphere of the sound field. Modest overall sound pressure levels (OASPLs) were measured near the in-plane position, showing that thickness noise is not significant in hover when ATBs are

used; rotor tip-speed reductions reduced the average OASPL by nearly 8 dB in-plane and by nearly 5 dB at 12.6 deg below the rotor plane. O.C.

A93-29415* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

TILTROTOR GROUND NOISE REDUCTION FROM ROTOR PARAMETRIC CHANGES AS PREDICTED BY ROTONET

STEPHEN J. JUMPER, DEVON PRICHARD (Lockheed Engineering and Sciences Co., Hampton, VA), and ROBERT A. GOLUB (NASA, Langley Research Center, Hampton, VA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. refs

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A simple acoustic footprint trend study has been performed to determine the sensitivity of a tiltrotor aircraft to simple rotor design variations. Using the XV-15 aircraft as a baseline, the effects of blade number, rotor RPM, and chord on tone and broadband noise were predicted with the ROTONET noise code. Effects on EPNL, PNLT, and OASPL for level forward flight were considered.

Author

A93-29416 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DEVELOPMENT AND VALIDATION OF 'QUIET TAIL ROTOR' TECHNOLOGY

RAJARAMA K. SHENOY, ROBERT C. MOFFITT, CHARLES M. YOERKIE (Sikorsky Aircraft, Stratford, CT), and OTIS CHILDRESS, JR. (NASA, Langley Research Center, Hampton, VA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 11 p. Research supported by NASA refs (Contract NAS1-17146)

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Systematic research leading to the development and validation of a 'quiet' full-scale tail rotor is described in this paper. Hover performance and acoustic test results acquired on the Sikorsky tail rotor whirl test facility, and some early results from the just-concluded flight tests are provided. The results show that substantial reduction in noise signature can be achieved simultaneously with improvements in performance when advances in aerodynamic and aeroacoustic technologies are judiciously applied. Author

A93-29417

VALIDATION OF HIGH FREQUENCY AIRLOAD CALCULATIONS USING FULL SCALE FLIGHT TEST ACOUSTIC DATA

A. C. PIKE (Westland Helicopters, Ltd., Yeovil, United Kingdom) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 14 p. refs

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An account is given of the development of aeroacoustic codes on the basis of acoustic measurements conducted on a Lynx helicopter with microphones at both the standard height of 1.2 m and inverted 7 mm above the ground. Attention is given to the validation of a method accounting for distortion of the measured waveforms due to ground reflections. Good reproductions are obtained for primary waveform characteristics, including variations in both blade vortex-interaction impulse and amplitude with observer position. O.C.

A93-29418

NOTAR SYSTEM - A QUIET CHARACTER

JEFFREY M. CURRIER, MARK HARDESTY, and JAMES M. O'CONNELL (McDonnell Douglas Helicopter Co., Research and Technology Div., Mesa, AZ) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft

Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 9 p.

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An account is given of the unique acoustic advantages of the 'NOTAR' rotorless helicopter control system in view of comparisons conducted between conventional tail rotor-equipped MD 500E and a NOTAR-equipped MD 520N helicopters. The noise reduction is most marked in the case of level-flyover; the noise-signature directivity of the helicopters differs significantly between them, due to the blowing of the NOTAR system thruster on the left side of the aircraft. O.C.

A93-29419

ACOUSTIC CHARACTERISTICS OF ADVANCED MODEL ROTOR SYSTEMS

JUDITH M. GALLMAN and SANDY R. LIU (U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 11 p. refs

Three separate wind tunnel tests were completed under the Aerodynamic and Acoustic Testing of Model Rotors Program. A subset of the acoustic data acquired in this test program has been assembled from three unique rotor systems. Variations in sound pressure level with thrust coefficient in hover, advance ratio in forward flight, and shaft angle tilt in descent are compared for these rotor systems. These comparisons show that in the hover flight regime, sound pressure level is proportional to thrust coefficient and is independent of rotor geometry. In forward flight, the redistribution of lift over the rotor has a great effect on the acoustic characteristics. The effects is different for each rotor system. Contour plots are shown for descending flight. As expected, the highest levels of blade vortex interaction noise are directed 25 deg below the rotor plane for all three systems. Author

A93-29420 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ACOUSTICAL ANALYSIS OF GEAR HOUSING VIBRATION

A. F. SEYBERT, T. W. WU, X. F. WU (Kentucky Univ., Lexington), and FRED B. OSWALD (NASA, Lewis Research Center, Cleveland, OH) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 8 p. Previously announced in STAR as N91-25411 refs (Contract RTOP 505-63-51)

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The modal and acoustical analysis of the NASA gear-noise rig is described. Experimental modal analysis techniques were used to determine the modes of vibration of the transmission housing. The resulting modal data were then used in a boundary element method (BEM) analysis to calculate the sound pressure and sound intensity on the surface of the housing as well as the radiation efficiency of each mode. The radiation efficiencies of the transmission housing modes are compared with theoretical results for finite, baffled plates. A method that uses the measured mode shapes and the BEM to predict the effect of simple structural changes on the sound radiation efficiency of the modes of vibration is also described. Author

A93-29424

HUMAN RESPONSE TO HELICOPTER NOISE - A TEST OF A-WEIGHTING

PAUL D. SCHOMER, BRIAN D. HOOVER, and LEE R. WAGNER (U.S. Army, Construction Engineering Research Lab., Champaign, IL) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 17 p. Previously announced in STAR as N92-17506 refs

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Department of Defense and U.S. Army policy has long been to adjust measured helicopter noise levels upwards to account for the special character of helicopter noise in terms of human and community annoyance. In the United States, the A-weighted Day/Night Average Sound Level (DNL) descriptor is used most often for this purpose, but research has shown that it is not completely adequate. Also, many questions remain about human perception of, and response to, helicopter noise. This study is an extension of earlier research that tested human response to the noise of an Army UH-1H (Huey) helicopter flow over various indoor environments. This report documents a follow-up test using six different helicopters to replicate and expand on the earlier study. The data generally indicate that the A-weighted DNL is inadequate for assessing helicopter noise. The C-weighted scale was also tried and found inadequate. Helicopter noise measurement by either scale must be corrected to accurately correspond to human perceptions. Measuring indoors, the use of A-weighting to assess helicopter noise requires an offset that varies with helicopter A-weighted sound exposure level (ASEL), and this offset varies for different helicopters. Author

A93-29425* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ACTIVE CONTROL OF INTERIOR NOISE IN A LARGE SCALE CYLINDER USING PIEZOELECTRIC ACTUATORS

H. C. LESTER and R. J. SILCOX (NASA, Langley Research Center, Hampton, VA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 18 p. Previously announced in STAR as N92-32958 refs

Copyright

The noise reduction effectiveness of two types of control force actuator models has been analytically investigated: (1) a point actuator, and (2) an in-plane, piezoelectric actuator. The actuators were attached to the wall of a simply supported, elastic cylinder closed with rigid end caps. Control inputs to the actuators were determined such that the integrated square of the pressure over the interior of the vibrating cylinder was a minimum. Significant interior noise reductions were achieved for all actuator configurations, but especially for the structurally dominated response. Noise reduction of 9 dB to 26 dB were achieved using point force actuators, as well as localized and extended piezoelectric actuators. Control spillover was found to limit overall performance for all cases. However, the use of extended piezoelectric actuators was effective in reducing control spillover, without increasing the number of control degrees of freedom.

Author

A93-29428* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ACTIVE CONTROL OF HELICOPTER TRANSMISSION NOISE

R. H. SPENCER (Boeing Helicopters, Philadelphia, PA), M. J. BURKE, and G. W. TYE (Noise Cancellation Technologies, Inc., Linthicum, MD) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 13 p. Research supported by U.S. Army refs

(Contract NAS3-25421)

Copyright

An account is given of an effort to reduce helicopter transmission noise by 10 dB, using active methods, as part of the NASA-Lewis/U.S. Army Propulsion Directorate Advanced Rotorcraft Transmission technology integration and demonstration program. The transmission used as a test stand is that of the CH-47C forward rotor. Attention is presently given to the active control system's actuators, sensors, and control algorithms. O.C.

A93-29429

AN OVERVIEW OF POSSIBLE AND NOT-SO-POSSIBLE TASKS FOR ACTIVE CONTROL OF SOUND AND VIBRATION

ANDREAS H. VON FLOTOW (MIT, Cambridge, MA) *In* AHS

and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 21 p. refs

Copyright

While such passive approaches to helicopter sound and vibration control as vibration isolation/acoustic blocking, damping/acoustic absorption, and tuned absorbers, can be actively implemented and enhanced, active control methods transcend these possibilities. A survey is presently conducted of the literature generated by active-control research in recent years, with a view to emerging opportunities that do not risk instability, excessive development and production costs, and undue complexity. O.C.

A93-29430

BLADE-VORTEX INTERACTION DATA OBTAINED FROM A PRESSURE-INSTRUMENTED MODEL ROTOR AT THE DNW

PETER F. LORBER (United Technologies Research Center, East Hartford, CT) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 14 p. Research supported by United Technologies Research Center refs

Copyright

Blade surface pressure data obtained during a model helicopter rotor test are examined to determine the locations and strengths of impulsive loading events caused by blade vortex interactions (BVI). Data from 43 descent conditions are used to identify, locate, and characterize the BVI events. The combination of azimuthal, radial, and chordwise resolution has generated a detailed picture of the aerodynamic response of a rotor blade to BVI. The paper examines both global and local features of the interaction. Global features include the dependence of the impulsive airload strength and position on three independent parameters: rotor tip path plane angle, rotor thrust, and advance ratio. Local features are examined by using the unsteady pressure distributions to determine the strength and the chordwise dependence of the amplitude and phase of a representative BVI event. Author

A93-29433 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EULER SOLUTIONS TO NONLINEAR ACOUSTICS OF NON-LIFTING ROTOR BLADES

J. D. BAEDER (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA) *In* AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 16 p. Previously announced in STAR as N91-19826 refs

(Contract RTOP 505-61-51)

Copyright

For the first time a computational fluid dynamics (CFD) method is used to calculate directly the high-speed impulsive (HSI) noise of a non-lifting hovering rotor blade out to a distance of over three rotor radii. In order to accurately propagate the acoustic wave in a stable and efficient manner, an implicit upwind-biased Euler method is solved on a grid with points clustered along the line of propagation. A detailed validation of the code is performed for a rectangular rotor blade at tip Mach numbers ranging from 0.88 to 0.92. The agreement with experiment is excellent at both the sonic cylinder and at 2.18 rotor radii. The agreement at 3.09 rotor radii is still very good, showing improvements over the results from the best previous method. Grid sensitivity studies indicate that with special attention to the location of the boundaries a grid with approximately 60,000 points is adequate. This results in a computational time of approximately 40 minutes on a Cray-XMP. The practicality of the method to calculate HSI noise is demonstrated by expanding the scope of the investigation to examine the rectangular blade as well as a highly swept and tapered blade over a tip Mach number range of 0.80 to 0.95. Comparisons with experimental data are excellent and the advantages of planform modifications are clearly evident. New

insight is gained into the mechanisms of nonlinear propagation and the minimum distance at which a valid comparison of different rotors can be made: approximately two rotor radii from the center of rotation. Author

A93-29443
HELICOPTER NOISE STANDARDS - REQUIREMENTS, COMPLIANCE, AND IMPROVEMENTS

CHARLES COX (Bell Helicopter Textron, Inc., Fort Worth, TX) In AHS and Royal Aeronautical Society, Technical Specialists' Meeting on Rotorcraft Acoustics/Fluid Dynamics, Philadelphia, PA, Oct. 15-17, 1991, Proceedings Alexandria, VA American Helicopter Society 1991 15 p. refs
 Copyright

Accounts are presently given of noise certification standards for helicopters, representative compliance efforts and their costs, and proposed modifications to standards for the sake of complexity and cost reduction. Attention is given to the development of ICAO and FAA noise certification standards, as well as to the current certification status of 33 different helicopters that are undergoing development throughout the world. O.C.

N93-20546# National Inst. for Fusion Science, Nagoya (Japan).
BETA-LIMITING PHENOMENA IN HIGH-ASPECT-RATIO TOROIDAL HELICAL PLASMAS

K. ITOH, A. FUKUYAMA (Okayama Univ., Japan), and S.-I. ITOH (Kyoto Univ., Uji, Japan) Oct. 1992 34 p Submitted for publication
 (ISSN 0915-633X)
 (NIFS-188; AD-B169726L) Avail: CASI HC A03/MF A01

Evolutions of the local pressure gradient and the amplitude of the helical mode are studied near the critical pressure gradient against the linear resistive interchange instability in high aspect ratio toroidal helical plasmas. Three characteristic dynamic evolutions are identified; monotonous saturation, relaxation oscillation and periodic limit cycle solution. As the heating power is increased, the dynamic evolution changes from the monotonous saturation, to the relaxation oscillation and finally to the limit cycle. The time average of the pressure gradient is limited by the critical gradient against the linear stability. Dependences of the amplitude and period of the sawtooth oscillation on the heating power are also analyzed. Author (revised)

N93-21317*# Georgia Inst. of Tech., Atlanta.
EFFECT OF PERSONAL AND SITUATIONAL VARIABLES ON NOISE ANNOYANCE: WITH SPECIAL REFERENCE TO IMPLICATIONS FOR EN ROUTE NOISE Final Report

JAMES M. FIELDS Aug. 1992 243 p Sponsored in part by FAA
 (Contract NAS1-19061)
 (NASA-CR-189676; NAS 1.26:189676; DOT/FAA/EE-92/03)
 Avail: CASI HC A11/MF A03

Over 680 publications from 282 social surveys of residents' reactions to environmental noise have been examined to locate 495 published findings on 26 topics concerning non-noise explanations for residents' reactions to environmental noise. This report (1) tabulates the evidence on the 26 response topics, (2) identifies the 495 findings, and (3) discusses the implications for en route noise assessment. After controlling for noise level, over half of the social survey evidence indicates that noise annoyance is not strongly affected by any of the nine demographic variables examined (age, sex, social status, income, education, homeownership, type of dwelling, length of residence, or receipt of benefits from the noise source), but is positively associated with each of the five attitudinal variables examined (a fear of danger from the noise source, a sensitivity towards noise generally, the belief that the authorities can control the noise, the awareness of non-noise impacts of the source, and the belief that the noise source is not important). Author

N93-21368# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Abt. Technische Akustik.
CALCULATION OF NOISE EMISSION CAUSED BY JET AIRCRAFT DURING TAKEOFF, APPROACH AND HORIZONTAL FLYOVER [BERECHNUNG DER LAERMIMMISSION DURCH STRAHLFLUGZEUGE BEI START, LANDUNG UND HORIZONTALFLUG]

JAN BOETTCHER and ULF MICHEL Oct. 1991 43 p In GERMAN
 (ISSN 0939-298X)

(DLR-MITT-91-15; ETN-93-91916) Avail: CASI HC A03/MF A01; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

A prediction scheme for jet noise is applied for noise calculations. The results are discussed for the neighborhood of an airfield for which sound emission is shown in the form of contour plots. The noise reduction potential achievable by varying operational parameters is demonstrated and quantified. The variation of takeoff and landing procedures, the decrease of aircraft weight and flight Mach number, and the increase of the flight altitude are shown to possibly result in a partially substantial noise reduction. ESA

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A93-23870
RECENT DEVELOPMENTS IN AVIATION CASE LAW

JONATHAN M. HOFFMAN (Martin, Bischoff, Templeton, Langslet & Hoffman, Portland, OR) and PHILIP S. HARRIS (Lewis and Clark College, Portland, OR) Journal of Air Law and Commerce (ISSN 0021-8642) vol. 58, no. 1 Fall 1992 p. 1-101. refs
 Copyright

The present survey of significant cases and the decisions to which they have led over the last several years covers litigation involving in personam and subject matter jurisdiction, the Foreign Sovereign Immunities Act, product liability, the Federal Tort Claims act, and indemnity, preclusion, and arbitration cases. Also treated are injuries within the scope of the Warsaw convention, punitive and pecuniary damages, FAA enforcement and local regulation, and negligence, bankruptcy proceedings, and the status of frequent-flier programs. O.C.

A93-23872
OBSTACLES TO INCREASING AIRSPACE - JUMPING THROUGH ENVIRONMENTAL LAW HOOPS

TOM NEUHOFF, JR. Journal of Air Law and Commerce (ISSN 0021-8642) vol. 58, no. 1 Fall 1992 p. 221-266. refs
 Copyright

An investigation is conducted to ascertain whether any major obstacles exist in Federal law to the expansion of airspace, in view of the suggestion of current case law that courts will defer to Federal agency judgment as long as said agency performs the requisite studies before allowing that increase. Attention is given to the fact that the agencies, especially when military, have a direct interest in the outcome of their studies. It is also noted that environmental concerns must remain a vital area of EPA oversight. O.C.

A93-24252

TERRORISM AND AIR-SPECIFIC PERILS AND THE LIABILITY OF AIR FREIGHT CARRIERS UNDER ARTICLE 17 OF THE WARSAW AGREEMENT [TERRORISMUS UND LUFTSPEZIFISCHE GEFAHR IN BEZUG AUF EINE HAFTUNG DES LUFTFRACHTFUEHRERS GEMAESS ARTIKEL 17 DES WARSCHAUER ABKOMMENS]

THOMAS KUZNICKI (Koeln, Univ., Cologne, Germany) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329) vol. 41, no. 4 Dec. 1992 p. 360-376. In German. refs
Copyright

The approach of the United States, France, Germany, and Israel to liability under Article 17 of the Warsaw Convention of air freight carriers following terrorist incidents and other mishaps is discussed. Problems involved in the definition of a terrorist act are addressed. C.D.

A93-24253

RESPONSIBILITY AND ASSIGNMENT OF ROLES ON OVERLONG FLIGHTS [VERANTWORTUNG UND ROLLENVERTEILUNG AN BORD BEI UEBERLANGEN FLUEGEN]

KLAUS J. SCHEER Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329) vol. 41, no. 4 Dec. 1992 p. 377-386. In German. refs
Copyright

Legal provisions regarding overlong aircraft flights are discussed. The roles of the pilot and senior first officer are addressed along with the applicable ICAO rules, law of the sea, national law, European law, and the rules of the Lufthansa flight operations manual. C.D.

A93-24296#

THE DEVELOPMENT OF A MATURE EXTERNAL MASTER'S DEGREE PROGRAM IN AERONAUTICAL ENGINEERING - A UNIVERSITY/INDUSTRY PARTNERSHIP

CONRAD F. NEWBERRY, ALI R. AHMADI, JULIE M. SCHOENUNG (California State Polytechnic Univ., Pomona), ALICE A. LE BEL, DAVID J. MCNALLY (Northrop Corp., Hawthorne, CA), and VAN H. GARNER (California State Polytechnic Univ., Pomona) Aug. 1992 21 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992 refs
(AIAA PAPER 92-4256) Copyright

In the summer of 1984 Northrop Corporation notified California State Polytechnic University, Pomona (Cal Poly, Pomona; CSPUP) that the CSPUP proposal for an onsite external Master's degree program had been accepted. This paper reviews the development of this program, admission requirements, course offerings, annual quality reviews (by both Northrop and Cal Poly, Pomona), fee assessments, matriculation summaries, evolutionary program changes and keys to the program's success. Since its inception in the fall of 1984, the program has evolved and matured in terms of curriculum development, student advising and degree requirements into a highly successful, streamlined and focused graduate aeronautical engineering program. Possible changes in the program's future direction are also discussed. Author

A93-24300#

METHODS OF ECONOMIC EVALUATION - FORECASTING CRITIQUE

WINSTON MAHABIR (Gulfstream Aerospace Corp., Savannah, GA) Aug. 1992 25 p. AIAA, Aircraft Design Systems Meeting, Hilton Head Island, SC, Aug. 24-26, 1992
(AIAA PAPER 92-4285) Copyright

Major flaws are identified in current commercial aircraft industry and airline fleet economic viability forecasting methods. An improved forecasting methodology must incorporate such considerations as the potential impact of adverse economic trends, competition from such surface transportation systems as railroads, airport congestion, and any other factors affecting airline traffic growth. Closer collaboration with economic forecasters should be considered. O.C.

A93-26011

DEVELOPMENT OF A MODEL TO PREDICT ELECTRIC VEHICLE PERFORMANCE OVER A VARIETY OF DRIVING CONDITIONS

FRANK E. WICKS and DARRYL MARCHIONNE (Union College, Schenectady, NY) In IECEC '92; Proceedings of the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, Aug. 3-7, 1992. Vol. 3 Warrendale, PA Society of Automotive Engineers, Inc. 1992 p. 3.151-3.158. Research supported by Niagara Mohawk Power Corp. refs
Copyright

This paper develops a mathematical model of an electric vehicle in terms of power and energy requirements and conversion components, and presents an equivalent circuit model of the batteries as a function of the charge condition, with the battery parameters obtained from charge-discharge testing, and demonstrates the use of this model to predict vehicle performance over a variety of driving and battery conditions. Author

A93-27133

FUTURE AVAILABILITY OF AIRCRAFT MAINTENANCE PERSONNEL

WILLIAM T. SHEPHERD (FAA, Office of Aviation Medicine, Washington) and JAMES F. PARKER, JR. (Biotechnology, Inc., Falls Church, VA) In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 33-36. refs

Copyright

Trends in the availability of aircraft maintenance personnel projected into the next century are examined. It is pointed out that the number of people available in this decade and in future years for the aircraft maintenance jobs is steadily diminishing. The downtrend may well accelerate as industry increasingly recognizes the skills available in the aircraft maintenance personnel workforce. This paper investigates various demographic and industry operational forecasts and discusses their impact on aircraft maintenance and inspection. I.S.

A93-27164

A CONTEXT-BASED INTRODUCTION TO AIRCRAFT RADIO COMMUNICATIONS

MARTHA H. WELLER and CHRISTOPHER D. WICKENS (Illinois Univ., Savoy) In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 518-522. Copyright

To the naive observer, aircraft radio communications can be as incomprehensible as a foreign language. As with any language, understanding what is said requires not only a knowledge of specific terms, but also a familiarity with the context in which the communication occurs. The novice, whether a beginning pilot or a researcher involved in aviation-related investigations, is too often expected simply to pick up such knowledge on the job. We have developed a set of computer-based training materials that provides the user with the necessary conceptual framework as well as the specific vocabulary used in basic flight contexts. The design, content, use by students, and plans for future development are discussed. Author

A93-27165

UTILIZING A MICROCOMPUTER BASED FLIGHT SIMULATION IN TEACHING HUMAN FACTORS IN AVIATION

WILLIAM F. MORONEY (Dayton Univ., OH) and BRIAN W. MORONEY (Villanova Univ., PA) In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 523-527. refs

Copyright

This paper describes the use of Microsoft's 'Flight Simulator' and 'Flight Simulator: Aircraft and Scenery Designer' in teaching human factors in aviation to psychology and engineering students. The student's role commenced as that of a participant-observer

and concluded as that of a scientist-practitioner. Flight Simulator was used to familiarize the student with aerodynamic principles, the relationship between aircraft controls and displays and flight dynamics. Both the syllabus incorporating the flight simulation and the capabilities of the simulation are described. The authors examined the capabilities of the simulations and feel that they provide an excellent return for a comparatively small investment. Students felt that the ability to use a simulator greatly enhanced the course. The simulations have potential applications which remain to be tapped. As a teaching aid, it is rated 'best buy'.

Author

A93-27166

USING TRACON AS A TEACHING TOOL

MARK W. SMOLENSKY (FAA Technical Center, Pomona, NJ) /In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 1 Santa Monica, CA Human Factors Society 1991 p. 528-531. refs

Copyright

The paper evaluates the usefulness of a modestly priced air traffic control simulator for personal computers, TRACON (Terminal Radar Approach Control), as a teaching tool for persons involved in teaching human factors. TRACON incorporates realistic features present in either the current TRACON radar scope, or in the next generation radar scopes currently in development, and simulates real-time operations. TRACON can be used to illustrate the following aspects of teaching: methods for evaluating individual differences; issues of decision making; concepts of part versus whole training, learning enhancement, practice, and knowledge of results; aids and strategies for enhancing memory retention; various ways of assessing human performance; the relationship between work load and fatigue; the concept of situation awareness; and various ways systems and humans can be evaluated to assess the effectiveness of human factors intervention. I.S.

A93-27189

THE ANALYSIS OF EXPERT PERFORMANCE IN THE REDESIGN OF THE EN ROUTE AIR TRAFFIC CONTROL CURRICULUM

RICHARD E. REDDING, JOHN R. CANNON, BRUCE C. LIERMAN (Human Technology, Inc., McLean, VA), JOAN M. RYDER, JANINE A. PURCELL (CHI Systems, Inc., Spring House, PA), and THOMAS L. SEAMSTER (Carlow Associates, Inc., Fairfax, VA) /In Human Factors Society, Annual Meeting, 35th, San Francisco, CA, Sept. 2-6, 1991, Proceedings. Vol. 2 Santa Monica, CA Human Factors Society 1991 p. 1403-1407. Research supported by FAA refs

Copyright

This paper describes a cognitive task analysis performed within an integrated framework to analyze knowledge structures, mental models, skills, and strategies of the en route controllers to provide an understanding of the key cognitive components of the controller's job. Seven different procedures were used to collect cognitive data, and this presentation concentrates on the results of three of those procedures as they contributed to an understanding of controller expertise. The procedures under discussion include performance modeling, structured problem solving, and paper problem solving. The performance modeling resulted in the identification of twelve primary tasks and a mental model made up of eight panels that underlie expert controller's organization of domain knowledge. The structured problem solving involved protocol analysis that resulted in the identification of three categories of controller strategies, and the paper problem solving resulted in a hierarchy of goals and a set of methods used by experts to achieve those goals. These results were integrated into a model of the expert controller that will be used to specify the instructional content and sequencing for the new curriculum.

Author

A93-29575

CONTROL OF LAND USE NEAR AIRPORTS IS BEST MEANS OF REDUCING IMPACT OF AIRCRAFT NOISE

RAY WALDER (IATA, Montreal, Canada) ICAO Journal (ISSN 0018-8778) vol. 48, no. 1 Jan.-Feb. 1993 p. 8-11.

Copyright

While the process of establishing the appropriate use of land near airports can be resorted to by those who wish to limit airport growth by precluding expansion, those who desire the continued expansion of air transport may turn to land-use zoning as a way of protecting the land required for future airport expansion. Since noise-reduction gains from technology are much less likely now than in the past, it is imperative that populations be kept away from airports. O.C.

N93-19970*# San Jose State Univ., CA.

ON THE TYPOGRAPHY OF FLIGHT-DECK DOCUMENTATION

ASAF DEGANI Dec. 1992 40 p

(Contract NCC2-327)

(NASA-CR-177605; A-93049; NAS 1.26:177605) Avail: CASI HC A03/MF A01

Many types of paper documentation are employed on the flight-deck. They range from a simple checklist card to a bulky Aircraft Flight Manual (AFM). Some of these documentations have typographical and graphical deficiencies; yet, many cockpit tasks such as conducting checklists, way-point entry, limitations and performance calculations, and many more, require the use of these documents. Moreover, during emergency and abnormal situations, the flight crews' effectiveness in combating the situation is highly dependent on such documentation; accessing and reading procedures has a significant impact on flight safety. Although flight-deck documentation are an important (and sometimes critical) form of display in the modern cockpit, there is a dearth of information on how to effectively design these displays. The object of this report is to provide a summary of the available literature regarding the design and typographical aspects of printed matter. The report attempts 'to bridge' the gap between basic research about typography, and the kind of information needed by designers of flight-deck documentation. The report focuses on typographical factors such as type-faces, character height, use of lower- and upper-case characters, line length, and spacing. Some graphical aspects such as layout, color coding, fonts, and character contrast are also discussed. In addition, several aspects of cockpit reading conditions such as glare, angular alignment, and paper quality are addressed. Finally, a list of recommendations for the graphical design of flight-deck documentation is provided. Author (revised)

N93-20048# Florida Univ., Gainesville.

MANAGEMENT OF AUTOMATIC DATA PROCESSING (ADP) SYSTEM DOCUMENTATION IN THE DEPARTMENT OF DEFENSE

TAMMY P. CAMPBELL 1992 17 p

(Contract N00123-89-G-0549)

(AD-A258507) Avail: CASI HC A03/MF A01

One aspect of management of ADP (Automated Data Processing) in the Federal Government is system documentation. Good system documentation is the backbone to the success of any automated system, for only through complete and thorough documentation can the user fully understand and utilize a system's capability. The system reviewed is the Naval Air Logistics Command Management Information System (NALCOMIS). The review is approached from the user's aspect. The review of this system involves the level of ability required for the user to understand and properly use the functionality provided by the system, the documentation requirements, and the problems associated with the user's interface to the system. Many problems exist with computer manuals that contained an inappropriate level of technical detail, style, format, and content. The positive and negative aspects of the user documentation and recommendations or suggestions to improve the documentation for the user's benefit are demonstrated. GRA

N93-20388# Army Aviation Center, Fort Rucker, AL. Aviation Technical Library.

USA AVIATION DIGEST INDEX, 1989, VOLUME 11 Final Report, Jan. - Dec. 1989

BEVERLY M. HALL, DEIRDRE D. KENNEDY, and GWENDOLYN MCGUIRE Nov. 1992 47 p
(AD-A258673) Avail: CASI HC A03/MF A01

This is an author and subject index of articles published in the United States Army Aviation Digest. Articles by and about an individual will appear under his/her name. GRA

N93-20389# Army Aviation Center, Fort Rucker, AL. Aviation Technical Library.

INDEX TO USA AVIATION DIGEST, 1990 Final Report, Jan. - Dec. 1990

BEVERLY M. HALL, DEIRDRE D. KENNEDY, and GWENDOLYN MCGUIRE Nov. 1992 38 p
(AD-A258678) Avail: CASI HC A03/MF A01

This is an author and subject index of articles published in the United States Army Aviation Digest. Articles by and about an individual will appear under his/her name. GRA

N93-20390# Army Aviation Center, Fort Rucker, AL. Aviation Technical Library.

INDEX TO USA AVIATION DIGEST, 1991 Final Report, Jan. - Dec. 1991

BEVERLY M. HALL, DEIRDRE D. KENNEDY, and GWENDOLYN MCGUIRE Nov. 1992 34 p
(AD-A258679) Avail: CASI HC A03/MF A01

This is an author and subject index of articles published in the United States Army Aviation Digest. Articles by and about an individual will appear under his/her name. GRA

N93-20403# Wright Lab., Wright-Patterson AFB, OH.

WRIGHT LABORATORY RESEARCH AND DEVELOPMENT FACILITIES HANDBOOK

MARGARET B. SKUJINS Aug. 1992 411 p Supersedes WRDC-TR-90-0001
(AD-A258746; WL-TR-92-0004; WRDC-TR-90-0001) Avail: CASI HC A18/MF A04

This handbook contains a listing of Wright Laboratory research and development facilities located at Wright Patterson AFB, OH and Eglin AFB, FL. Facilities included are those of the Aero Propulsion and Power, Armament, Avionics, Flight Dynamics, Materials, Plans and Programs, and Solid State Electronic Directorates. Documented listings include information on facility type, capabilities, instrumentation, availability, and point of contact. GRA

N93-20611# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

DESIGN RECOVERY FOR SOFTWARE LIBRARY POPULATION M.S. Thesis

CHESTER A. WRIGHT, JR. Dec. 1992 92 p
(AD-A259292; AFIT/GCS/ENG/92D-23) Avail: CASI HC A05/MF A01

This thesis research investigated design recovery as a means of populating a reuse library. The targeted library was part of the Automatic Programming Technologies for Avionics Systems (APTAS). APTAS uses a knowledge base of forms, to present questions to a user, and rules, to select the forms to present and choose existing library modules to use in composing a new system. The approach applied the reengineering model developed in earlier work to accomplish planning for the project, expanded the renovation phase of this model to cover the actual design recovery, and applied the expanded model to populating the library. Using the model in the project showed that design recovery is feasible in populating the library. However, if the recovered design could not be used directly, it could be used as a guide in developing new components. Additionally, certain modules make better candidates than others. Ideal candidates are self-contained in that they receive a value, perform a computation, and return a value. Once the module starts performing too many operations, expertise is required in the module behavior in order to separate the component for reuse. GRA

N93-20734# Rolls-Royce Ltd., Derby (England).

HANDLING AND USING INFORMATION SYSTEMS WITH NEW TECHNOLOGY

A. A. AITKEN 1 Nov. 1991 9 p
(PNR-90910; ETN-92-92760) Copyright Avail: CASI HC A02/MF A01

The action and planning carried out by an engine manufacturer, to take advantage of the advances available in order to provide maintenance information in a manner which reduces the efficiency of those using the information, and permits interactive use of data from multiple databases, are addressed. The method chosen to carry information is described and the benefits gained from a compact data storage medium capable of being accommodated and utilized on low cost hardware platforms, are outlined. In portraying the activities, the preparatory background necessary to arrive at today's achievement and the potential available as a result are discussed. The route ahead is examined and further advances are discussed. ESA

N93-21794# National Aeronautics and Space Administration, Washington, DC.

NASA SBIR ABSTRACTS OF 1990 PHASE 1 PROJECTS

F. C. SCHWENK (Futron Corp., Bethesda, MD.), J. A. GILMAN (Futron Corp., Bethesda, MD.), and J. B. PAIGE (Futron Corp., Bethesda, MD.) Aug. 1991 112 p
(NASA-TM-108145; NASA-SBIR-PC-90; NAS 1.15:108145) Avail: CASI HC A06/MF A02

The research objectives of the 280 projects placed under contract in the National Aeronautics and Space Administration (NASA) 1990 Small Business Innovation Research (SBIR) Phase 1 program are described. The basic document consists of edited, non-proprietary abstracts of the winning proposals submitted by small businesses in response to NASA's 1990 SBIR Phase 1 Program Solicitation. The abstracts are presented under the 15 technical topics within which Phase 1 proposals were solicited. Each project was assigned a sequential identifying number from 001 to 280, in order of its appearance in the body of the report. The document also includes Appendixes to provide additional information about the SBIR program and permit cross-reference in the 1990 Phase 1 projects by company name, location by state, principal investigator, NASA field center responsible for management of each project, and NASA contract number.

Author (revised)

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GENERAL

N93-21022# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Abt. Operative Unternehmensplanung.

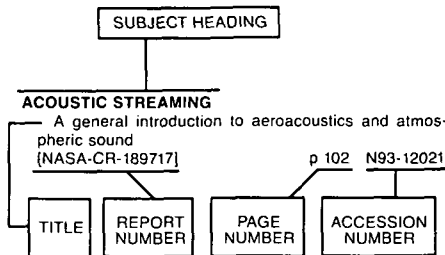
SUMMARIES OF THE 1991 PUBLICATIONS OF DLR RESEARCH REPORTS AND DLR COMMUNICATIONS [JAHRESVERZEICHNIS 1991. DLR-FORSCHUNGSBERICHT UND DLR-MITTEILUNGEN]

W. WILKE Mar. 1992 34 p In GERMAN
(ISSN 0939-2971)

(ETN-93-92588) Avail: CASI HC A03/MF A01

Abstracts for DLR research reports are presented. Research topics analyzed included the following: flight mechanics, inflight operational procedure, flight medicine, traffic research, theoretical and experimental flow mechanics, design aerodynamics, drive technique, structural mechanics, design aerodynamics, aeroelasticity, material research, space simulation, high frequency technique, and atmospheric physics. ESA

Typical Subject Index Listing



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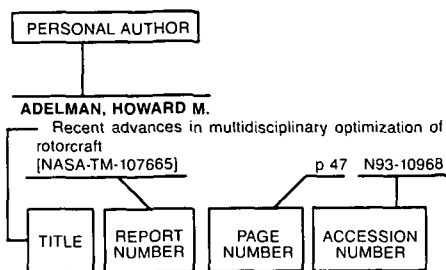
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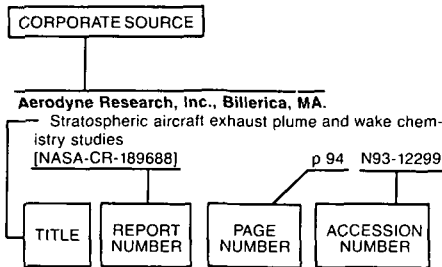
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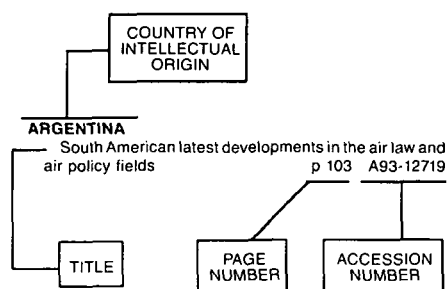
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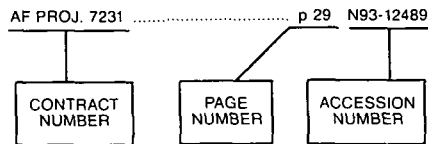
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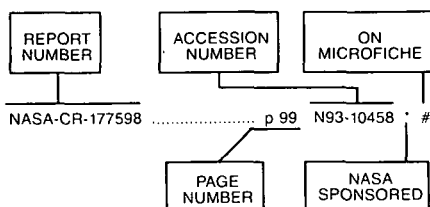
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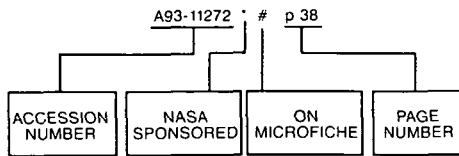
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